DATALOGIC™

# *Safety Control Unit*

SG EASY One

## INSTRUCTION MANUAL

**DATALOGIC AUTOMATION**
Via S. Vitalino 13 - 40012 Calderara di Reno - Bologna - Italy
Tel: +39 051 3147011 - Fax: +39 051 3147453

**Operations Office**
Via Lavino 265 - 40050 Monte S.Pietro - Bologna – Italy
Tel: +39 051 6765611 - Fax: +39 051 6759324

*www.automation.datalogic.com e-mail:info.automation@datalogic.com*

DATALOGIC AUTOMATION reserves the right to make modifications and improvements without prior notification.
*Datalogic and the Datalogic logo are registered trademarks of Datalogic S.p.A. in many countries, including the U.S.A. and the E.U.*

**826004210 rev.00** *© Copyright Datalogic 2009*

# SAFETY PRECAUTIONS

- Carefully read this user's manual to ensure correct operation before starting installation, wiring, operation, maintenance, and inspection of the SG-ONE.
- In this user's manual, safety precautions are categorized in order of importance- Warning and Caution, as follows:

**Warning** Warning notices are used to emphasize that improper operation may cause severe personal injury or death.

**Caution** Caution notices are used where inattention might cause personal injury or damage to equipment.

## Warning

- Do not disassemble, repair, or modify SG-ONE. This will cause impairment of the safe operability of SG-ONE.
- Turn off the power to SG-ONE before starting installation, removing, wiring, maintenance, or inspection of SG-ONE. This can cause electrical shocks or fire hazard.
- Before operating SG-ONE, carefully read the instruction sheet and this manual, and ensure that the environment conforms to the requirements of SG-ONE specifications. If SG-ONE is operated in an environment that exceeds the specifications of SG-ONE, it causes impairment of the safe operation of SG-ONE.
- The installation, wiring, configuration, and operation of SG-ONE must be performed only by "Safety responsible persons". Safety responsible persons are personal who have requisite qualification authorizing them as being capable of safely carrying out each step including the designing, installation, operation, maintenance, and disposal of SG-ONE. Persons without this technical expertise must not use SG-ONE.
- SG-ONE must be subjected to regular proof test verification that each function of SG-ONE is performing up to the required standard.
- An operational check must be performed daily on the SG-ONE.
- Installation of SG-ONE must be performed according to the instructions found in the instruction sheet and this manual. Improper installation may cause the SG-ONE to fail.
- Do not use the monitor outputs or solenoid/lamp outputs as a safety outputs. When there is a failure in SG-ONE or peripheral devices, Impairment of the safe operation of the system is possible.
- Do not use the start input and the external device monitor input as a safety input. When there is a failure in SG-ONE or peripheral devices, Impairment of the safe operability of the system is possible.
- Use the SG-ONE in compliance with laws and regulations of the country in which it is being used.
- Use safety inputs and safety outputs in circuit configurations conforming to the application according to the usage, and the safety requirements.

**Warning**

- Calculate respective safety distances, taking into consideration the response time of the SG-ONE, safety devices to be connected to the SG-ONE, and each other device that forms a part of the system configuration.
- Applicable safety performance is dependent on each system configuration.
- Use a power supply that meets following required specifications:
  -Conforms to the power supply rating of SG-ONE
  -Has the functionality or the functional equivalent of the control voltage and current of class 2 circuit, as defined in UL508 or UL1310.
  -Is in compliance with safety laws and regulations relating to electrical safety, EMC, and like under the laws and regulations of the country in which it is being used.
- Ground the V- line (0V DC) for ground diagnosis.
- In the case of a new configuration or modified installation, be sure to perform a check for each input and output function.
- Implement protective measures that personal, other than safety responsible persons operating the SG-ONE, are unable to modify the configuration.
- Separate SG-ONE from devices and wires which are not according to class 2 circuit requirements.
- The following sentence is added in power supply requirments instead of a insulation condition.
  - Complies with the SELV/ PELV circuit specified by EN 50178 or EN60950.
- The following new sentence is added in the above "SAFETY PRECAUTIONS".
  - The start switch has to be placed outside the danger zone and in a safe position from which there is good visibility for checking that no person is within the danger zone.

**Warning**

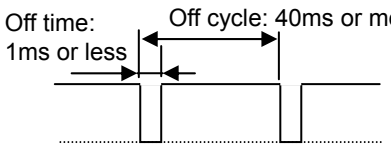
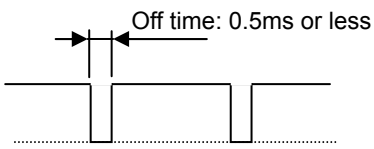
- Do not connect devices having input and output specifications that do not satisfy the requirements of the SG-ONE.

  Refer to the following for information on the requirements of connected devices.

| Connected Control Device | Requirements |
|---|---|
| Emergency stop switch | Device equipped with a direct opening action mechanism conforming to IEC/EN60947-5-5 or indicated in IEC/EN60947-5-1 |
| Interlock switch,<br>limit switch | Device equipped with a direct opening action mechanism indicated in IEC/EN60947-5-1 |
| Safety switch with lock | Spring lock safety switch with solenoid |
| Mode select switch | Device conforming to regulations of the country where used and required categories (for example, switch conforming to IEC/EN60947-1) |
| Enabling switch | Device conforming to IEC/EN60947-5-8 (or IEC/EN60947-5-1) |
| Solid state output device | Device conforming to regulations of the country where used (for example, safety light curtain conforming to IEC/EN61496-1)<br>PNP output (See Note 1) |
| Non-contact interlock switch | Device designed to work together with hinged, sliding, or lift-off guards and barriers conforming to regulations of the country where used |
| Safety relay | Relay equipped with forced guide mechanism or conforming to EN50205 |
| Contactor<br>(electromagnetic switch) | Contactor equipped with forced guide mechanism |
| Other control devices | Use start switches and other devices that conform to the regulations of the country where used. |
| Muting sensor | Device conforming to IEC/EN60947-5-2 as shown below<br>-3 wire transmission (dark on) photoelectric switch which has a PNP open collector output.<br>-3 wire (normal open) proximity switch which has a PNP open collector output. |
| Muting lamp | Incandescent bulb indicator light conforming to IEC/EN60947-1 or IEC/EN60947-5-1<br>Note 2: It is not possible to detect a disconnection of the muting lamp when using an LED indicator light. |

- Make sure that the end-user thoroughly understands the contents of this user's manual.

Note 1: Use the solid state output device that sends output signal of the waveforms shown below. Otherwise the SG-ONE cannot process the input signal correctly.

| Software version | 1.20 | 1.30 or later |
|---|---|---|
| Applicable solid state output device<br><br>(Waveform of solid sate output) | Pulse output off cycle of 40ms or more and an off time of 1ms or less.<br>  | Pulse output off time of 0.5ms or less or same as version 1.20.<br>  |

**The device may not be usable even if the above specifications are satisfied. Be sure to thoroughly confirm operations using the actual device.**

Software version is described at the next of serial number on the product label.

**Caution**

- SG-ONE is designed for installation within an enclosure. Do not install SG-ONE outside an enclosure. Install SG-ONE in enclosure rated IP54 or higher.
- Install SG-ONE in environments described in the catalog, instruction sheet, and user's manual. If SG-ONE is used in places where the SG-ONE is subjected to high temperature, high humidity, condensation, corrosive gases, excessive vibrations, and excessive shocks then electrical shocks, fire hazard, or malfunction may result.
- Environment for using the SG-ONE is "Pollution degree 2". Use SG-ONE in environments of pollution degree 2 (according to IEC/EN60664-1).
- Prevent SG-ONE from falling while moving or transporting of the SG-ONE, otherwise damage or malfunction of the SG-ONE may result.
- Prevent metal fragments and pieces of wire from dropping inside the SG-ONE housing. Put a cover on the SG-ONE during installation and wiring. Ingress of such fragments and chips may cause fire hazard, damage or malfunction.
- Install SG-ONE, so that there is adequate distance from the walls, heat generating bodies, and peripherals, taking into consideration space requirements for maintenance and ventilation.
- Install SG-ONE on 35mm DIN rails with BNL6 mounting clips (sold separately) on both sides of SG-ONE.
- Wire the connectors with conforming cables or ferrules.
- Ground FE terminal to assure electromagnetic compatibility.
- Use common 0V DC, if different power supplies are used for SG-ONE and other devices (ex. safety light curtain.
- Wire the inputs and outputs so that they are separated from power lines.
- When overcurrent flows into output terminals, the protective function turns off the output. However, when overcurrent status lasts long, internal protective elements will fuse. To protect the internal elements, insert fuses of double the rated value to each terminal.
- Use IEC60127 approved fuses on the power line of SG-ONE. (This is required for equipment incorporating SG-ONE that is destined for Europe.)
- When disposing of SG-ONE, handle it under the laws and regulations of the country in which it is disposed.

# BEFORE GETTING STARTED

Thank you for your purchase of the DATALOGIC AUTOMATION SG-ONE (Type Number SG-ONE-T4-8C).
This user's manual describes the specifications, and the procedures for installing and operating the SG-ONE.
Read this manual carefully before using the SG-ONE so that you have an adequate understanding of its functions and performance.

■ About directives and standards

SG-ONE is approved for following directives and standards by TÜV SÜD.

1. EU directives

-Machinery Directive: Directive 98/37/EC

-EMC Directive: Directive 2004/108/EC

2. EN standards / IEC standards / ISO standards

-IEC 61508 Part1-7, EN 954-1, ISO 13849-1, IEC/EN 62061, IEC/EN 61496-1, IEC/EN 61000-6-2, IEC/EN 61000-6-4

SG-ONE is approved for following directives and standards by UL.

1. UL standards

- UL 508

2. CSA standards

- CSA C22.2 No.142

**NOTE**

- The reproduction, transfer, sale, assignment, or loan of any or a part of this manual is strictly prohibited.
- The contents of this manual are subject to change without notice.
- Thorough measures have been taken in preparing the contents of this manual; however, in the case you find an error or the like, please bring it to the attention of your DATALOGIC AUTOMATION sales representative.

# CONTENTS


**Chapter1 OVERVIEW ..... 1-1**

About the SG-ONE ..... 1-1
Features of the SG-ONE ..... 1-2

**Chapter2 PRODUCT SPECIFICATIONS ..... 2-1**

**Chapter3 INSTALLATION AND WIRING ..... 3-1**

Installation method ..... 3-3
Wiring method ..... 3-6

**Chapter4 BASIC OPERATIONS ..... 4-1**

Turning on the power ..... 4-2
Using the protective cover ..... 4-2
Logic configuration ..... 4-3
Timer configuration ..... 4-5
Cancelling the Protection state ..... 4-7
Canceling the Stop state ..... 4-8

**Chapter5 LOGIC ..... 5-1**

Logic 1: General purpose logic for various apparatuses ..... 5-1
Logic 2: General purpose logic for NO/NC contact inputs ..... 5-10
Logic 3: General purpose logic for machines with openings ..... 5-20
Logic 4: Muting function logic for machines with openings ..... 5-30
Logic 5: General purpose logic for devices for which sync time between contacts cannot be specified ..... 5-40
Logic 6: The logic applicable for selection of an active safety input device ..... 5-49
Logic 7: Partial stop 1 logic for various machines ..... 5-60
Logic 8: Partial stop 2 logic for various machinery ..... 5-71
Logic functions ..... 5-81

**Chapter6 TROUBLE SHOOTING ..... 6-1**

Error descriptions and troubleshooting ..... 6-1

**Chapter7 APPENDIX ..... 7-1**

Minimum Distance ..... 7-1
Maintenance and Inspection ..... 7-6

# Chapter1 OVERVIEW

This chapter provides an understanding of the SG-ONE. Make efficient use of the SG-ONE by thoroughly familiarizing yourself with its functions.

## About the SG-ONE

The SG-ONE series of SG EASY ONE controllers provides safeguard measures for various factory automation equipment and systems, including robots, production machinery, semiconductor manufacturing apparatus, food packaging machinery, and printing machinery. You can easily configure the safety circuits by using multiple safety inputs and outputs and selecting the circuit (logic) built into the SG-ONE.

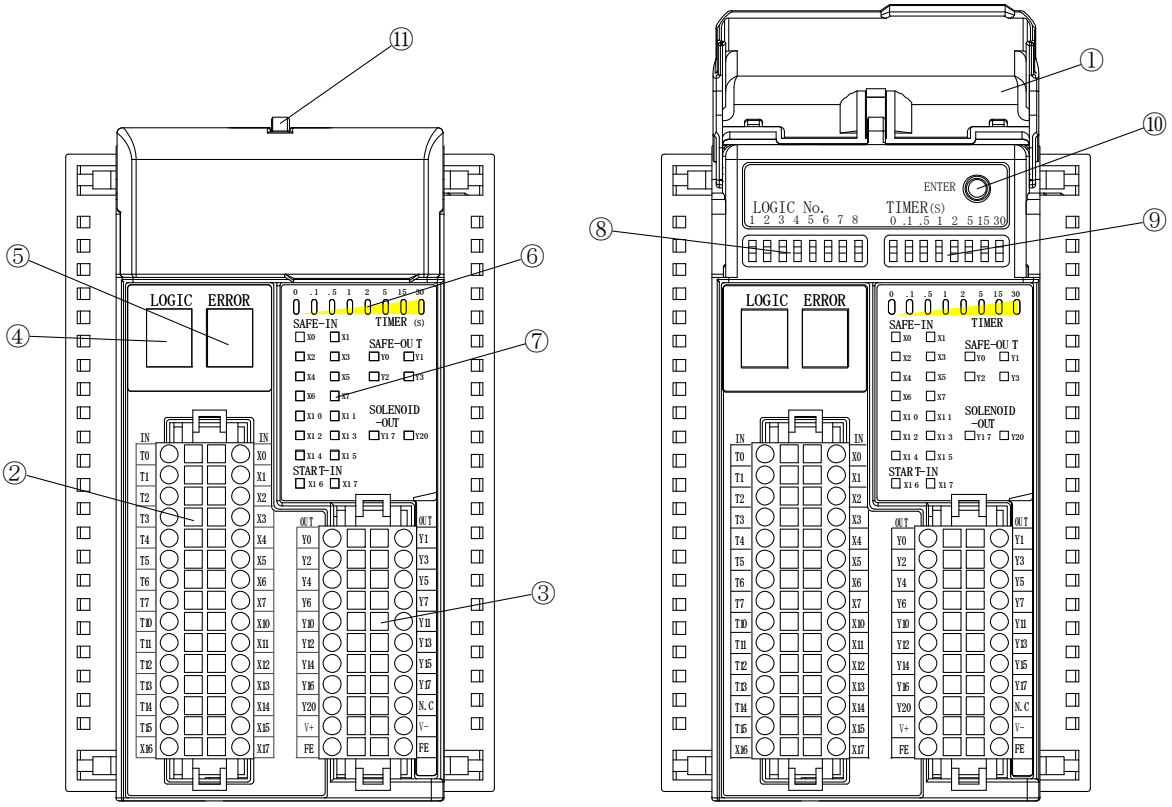
## Features of the SG-ONE

- **You can configure safety circuits without the use of complicated external wiring or special software, thereby greatly reducing the number of development man-hours required for product certification and the training time of safety responsible persons.**
- **You can use the DIP switches to select from eight different types of logic circuits and set the OFF-delay timer value to best match your application.**
  The SG-ONE has 16 DIP switches and an ENTER button, which can be used to set the built-in types of logic and the delay timer values for the safety output is OFF.
  Select from the following eight logic configurations.
  Logic 1: General-purpose logic for various apparatuses
  Logic 2: General-purpose logic for NO/NC contact inputs
  Logic 3: General-purpose logic for apparatuses with openings
  Logic 4: Muting function logic for apparatuses with openings
  Logic 5: General-purpose logic for devices for which sync time between contacts cannot be specified
  Logic 6: Mode switching logic for teaching and other device changes
  Logic 7: Partial stop 1 logic for various apparatuses
  Logic 8: Partial stop 2 logic for various apparatuses
  You can set the timer value to 0, 0.1, 0.5, 1, 2, 5, 15, or 30 seconds. You can set the stop category to 0 or 1.
- **Conforms to the international safety standards IEC 61508 SIL 3 and ISO 13849-1 PL e (Category 4).**
  The SG-ONE can be used for the functional safety standard IEC 61508 series and IEC 62061 SIL 1 to 3, which define the safety performance of machinery that uses microprocessors and software, and for performance levels a to e of ISO 13849-1 and Control category B to 4 of EN954-1, which define safety performance of machinery control systems.
- **You can directly connect an emergency stop switch, interlock switch, light curtain, and other various safety devices.**
  The SG-ONE provides dual channel direct opening inputs such as an emergency stop switch and interlock switch; dual channel NO/NC inputs such as a non-contact interlock switch; and dual channel solid state inputs such as a safety light curtain and safety laser scanner. These inputs can be enabled by selecting a certain type of logic, thereby enabling the various safety devices.
- **The SG-ONE comes with monitor outputs and solenoid/lamp outputs, which can be used as control signals.**
  With monitor outputs, you can monitor the status of the SG-ONE, including safety inputs and outputs and error information. When connected to a PLC, the SG-ONE can be used to control all apparatuses and the entire system. The SG-ONE is also provided with solenoid/lamp outputs, which can be used to directly control spring lock safety switches with solenoids. In logic4, muting lamps can be connected to solenoid/lamp outputs.
- **Obtain detailed diagnostic information with the LED displays**.
  The SG-ONE has two 7-segment LED displays for displaying internal information and 30 LED lights for displaying status. You can use these to display input and output information and to obtain detailed diagnostic information on the status of the SG-ONE.
- **Control multiple safety devices (12 safety inputs and 4 safety outputs) by a single unit.**
  The SG-ONE has 12 safety inputs and 4 safety outputs, and it can be configured for up to 6 dual channel inputs 2 dual channel outputs.

# Chapter2 PRODUCT SPECIFICATIONS

This chapter describes product specifications of the SG-ONE.

## Parts Descriptions

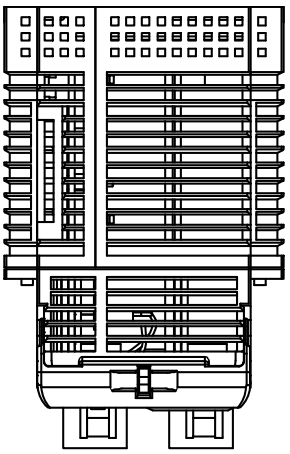


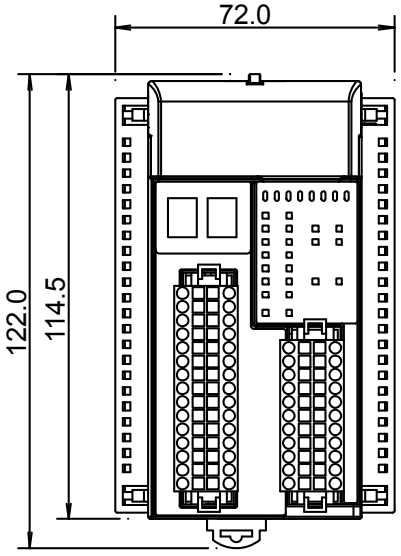

The protective cover is closed

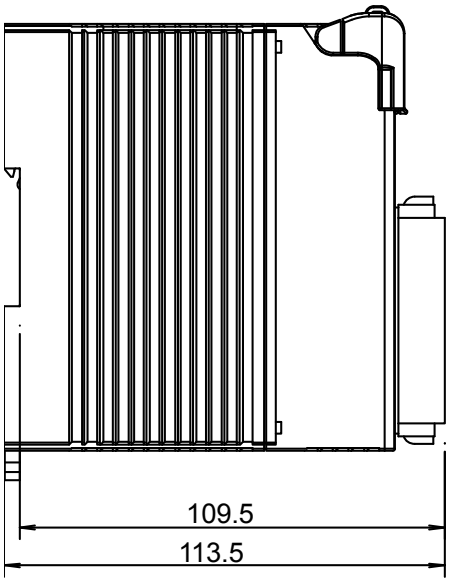
The protective cover is open

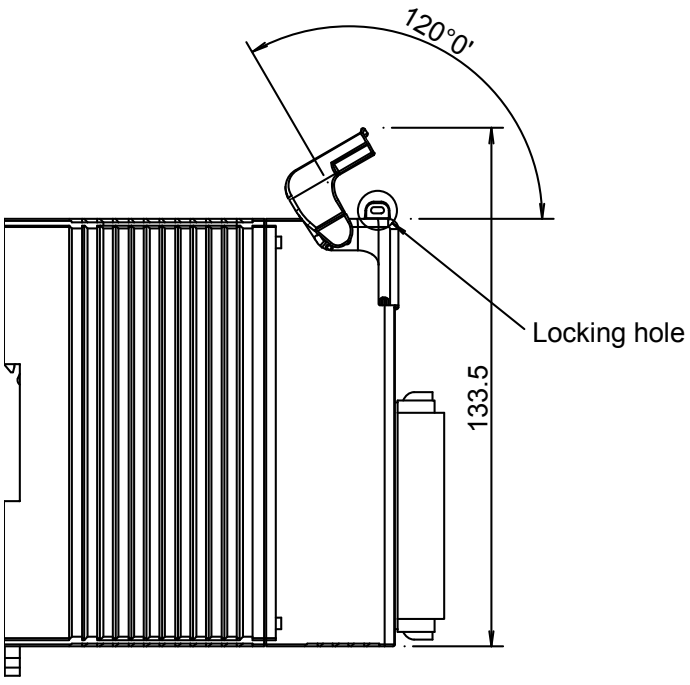
1. Protective cover: The cover protects unauthorized changing of configuration switches by use of a locking hole.
2. Input connector: Spring clamp connector for input devices.
   (Crimp connector can also be used.)
3. Output connector: Spring clamp connector for output devices and power supply.
   (Crimp connector can also be used)
4. Logic LED: The 7-segment green LED indicates the number of logic pattern selected.
5. Error LED: The 7-segment red LED indicates an error in the SG-ONE and peripherals.
6. Timer LED: The eight Timer LEDs indicate the selected timer value.
7. Input/output status LED: The input LEDs indicate the state of inputs.
   The output LEDs indicate the state of outputs.
   - SAFE-IN: Status of safe inputs, e.g. X0 … X15
   - START-IN: Status of start inputs, e.g. X16, 17
   - SAFE-OUT: Status of safe outputs, e.g. Y0 … Y3
   - SOLENOID-OUT: Status of solenoid outputs, e.g. Y17, 20
8. Logic switch: DIP switch for selecting the internal logic.
9. Timer switch: DIP switch for selecting the OFF-delay time for the safe output.
10. Enter button: button for activation of parameter changes.
11. Lock hole: hole for locking the protective cover

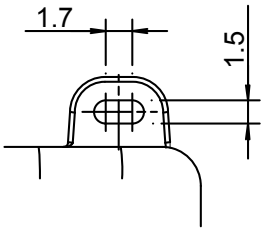
## Dimensions






Detail of locking hole

## General specifications

| | | |
|---|---|---|
| Operating conditions | | |
| | Operating temperature (Surrounding air temperature) | -10 to +55°C (no freezing) |
| | Relative operating humidity | 10 to 95% (non-condensing) |
| | Storage temperature | -40 to +70°C (no freezing) |
| | Relative storage humidity | 10 to 95% (non-condensing) |
| | Pollution degree | 2（IEC/EN 60664-1 |
| | Degree of protection | IP20 IEC/EN 60529 |
| | Corrosion immunity | Atmosphere be free from corrosive gas |
| | Altitude | Operation: 0 to 2,000m (0 to 6,565 feet) |
| | | Transportation: 0 to 3,000m (0 to 9,840 feet) |
| | Vibration resistance | Vibration （IEC/EN 61131-2:<br>5 to 8.4 Hz amplitude 3.5 mm,<br>8.4 to 150 Hz acceleration 9.8 $m/s^2$ (1G),<br>2 hours per each of XYZ axes<br>Bump (IEC/EN 61496-1):<br>Acceleration 98 $m/s^2$ (10G), 16ms duration, 1000 times per each of XYZ axes |
| | Shock resistance | 147 $m/s^2$ (15G), 11 ms duration, 3 times per each of XYZ axes (IEC/EN 61131-2) |
| | Connector durability | 50 times maximum |
| | Operation strength of configuration switches | 100 operations maximum (per 1 switch) |
| | Operation strength of enter button | 1000 operations maximum |
| | Enclosure material | modified-Poly Phenylene Ether (m-PPE) |
| | Weight | Approximately 330g |
| Electrical conditions | | |
| | Rated voltage | 24V DC |
| | Allowable voltage range | 20.4V DC to 28.8V DC |
| | Maximum power consumption | 48W (at 24V DC, all inputs and outputs are ON, includes output loads) |
| | Allowable momentary power interruption | 10ms minimum (at rated voltage DC) |
| | Reaction time | ON to OFF: 40 ms maximum Note1<br>: 100ms maximum Note2 |
| | | OFF to ON: 100 ms maximum Note3 |
| | Start-up time Note4 | 6s maximum |
| | Dielectric strength | Between live part and FE terminal: 500VAC, 1 minute |
| | | Between enclosure and FE terminal: 500VAC, 1 minute |
| | Insulation resistance | Between live part and FE terminal: 10MΩ minimum (at 500V DC megger) |
| | | Between enclosure and FE terminal: 10MΩ minimum (at 500V DC megger) |
| | Noise immunity (Noise simulator) | DC power terminals: 1.0 kV, 50 ns to 1 μs |
| | | I/O terminals: 2.0 kV, 50 ns to 1 μs (with coupling adapter) |
| | Inrush current | 25A maximum |
| | Grounding | Type D grounding (Type 3 grounding) |
| | Affect of improper power supply connection | Reverse polarity: No operation, no damage |
| | | Improper voltage: Permanent damage may occur |

Note1. Time to shut OFF safety outputs after safety inputs are turned OFF or input monitor error is detected (in case of OFF-delay timer is 0s). If the timer value except 0s, add the selected OFF-delay time to this reaction time.

Note2. Time to shut OFF safety outputs after error (except input monitor error) is detected, or configuration change is detected. This reaction time does not depend on OFF-delay timer value.

Note3. Time to turn ON safety outputs after safety inputs are turned ON (in case of auto start). In case of manual start, it means time turn ON safety outputs after start input is turned ON. In case of control start, it means time to turn ON safety outputs after start input transits from ON to OFF.

Note4. Time to change to Run state after power ON.

## Applicable standards

| Standard | Title |
|---|---|
| IEC 61508 Part1-7 | Functional safety of electrical/electronic/programmable electronic safety-related systems |
| EN 954-1 | Safety of Machinery -- Safety-related Parts of Control Systems -- Part 1: General Design Principles |
| ISO 13849-1 | Safety of machinery -- Safety-related parts of control systems -- Part 1: General principles for design |
| IEC/EN 62061 | Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems |
| IEC/EN 61496-1 | Safety of machinery - Electro-sensitive protective equipment - Part 1: General requirements and tests |
| IEC/EN 60204-1 | Safety of electrical machinery – General standard |
| IEC/EN 61131-2 | Programmable controllers Part 2: Equipment requirements and tests |
| IEC/EN 61000-6-2 | Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments |
| IEC/EN 61000-6-4 | Electromagnetic compatibility (EMC) – Part 6-4: Generic emission standards – Residential, commercial, and light industry |
| NFPA 79 | Electrical Standard for Industrial Machinery |
| ANSI/RIA R15.06 | American National Standard for Industrial Robot and Robot System – Safety Requirements |
| ISO 10218-1 | Manipulating industrial robots – Safety requirements – Part 1:Robot |
| ANSI B11.19 | American National Standard for Machine Tools – Safeguarding when referenced by the other B11 Machine Tool Safety Standards - Performance criteria for the design, construction, care, and operation |
| SEMI S2 0706 | Environmental, Health, and Safety Guideline for Semiconductor Manufacturing Equipment (Standard) |
| UL 508 | Industrial control equipment |
| CSA C22.2 No.142 | Process control equipment |
| UL1998 | Standard for Software in Programmable Components |
| UL1740 | Standard for Robots and Robotic Equipment |

## Safety performance

SG-ONE can be used in a system for category B to 4 and performance level “a” to “e” in accordance with ISO 13849-1: 2006.

**Average probability of failure on demand (PFD) and Probability of a dangerous failure per hour (PFH)**

The following table describes PFD and PFH. They are needed for calculation of safety integrity level (SIL) which is applied to a system with SG-ONE. SG-ONE can be used in a system for SIL 1 to 3.

| Proof test interval[Note1] | Average Probability of Failure on Demand (PFD) | Probability of a dangerous Failure per Hour (PFH) |
|---|---|---|
| 6 months | $< 1.8 \times 10^{-5}$ | $< 1.2 \times 10^{-8}$ |
| 1 year | $< 3.1 \times 10^{-5}$ | |
| 2 years | $< 5.7 \times 10^{-5}$ | |
| 5 years | $< 13.4 \times 10^{-5}$ | |

Note1: Refer to Maintenance and Inspection in “Chapter 7 APPENDIX” for proof test procedure.

**Mean Time To dangerous Failure ($MTTF_d$) and diagnostic coverage (DC)**

The following table describes $MTTF_d$ and DC. They are needed for the calculation of Performance Level (PL) which is applied to a system with SG-ONE. SG-ONE can be used in a system for PL a to e.

| Mean time to dangerous failure ($MTTF_d$) | Average Diagnostic Coverage (DC) |
|---|---|
| 100 years | 99% or more |

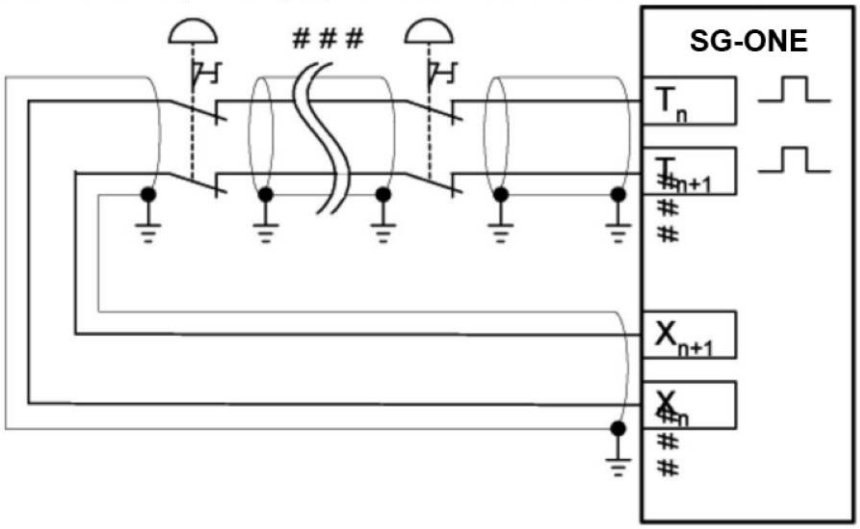
## Safety input specifications

| | | |
|---|---|---|
| Drive terminal specifications (T0, T1, T2, T3, T4, T5, T6, T7, T10, T11, T12, T13, T14, T15) | | |
| | Rated drive voltage | Power supply voltage |
| | Minimum drive voltage | Power supply voltage – 2.0V |
| | Number of drive terminals | 14 |
| | Maximum drive current | 20mA per port （at 28.8V DC） Note1 |
| Receive terminal specifications (X0, X1, X2, X3, X4, X5, X6, X7, X10, X11, X12, X13, X14, X15) | | |
| | Rated input voltage | 24V DC |
| | Input ON voltage | 15.0V DC to 28.8V DC |
| | Input OFF voltage | Open or 0V DC to 5.0V DC |
| | Number of receive terminals | 14 |
| | Rated input current | 10mA per port (at rated voltage) |
| | Type of input | Sink type input (for PNP output), Type 1 （IEC/EN 61131-2） |
| Wiring specifications | | |
| | Cable length Note2 | 100m maximum (total wiring length per 1 input) |
| | Allowable wiring resistance | 300Ω maximum |

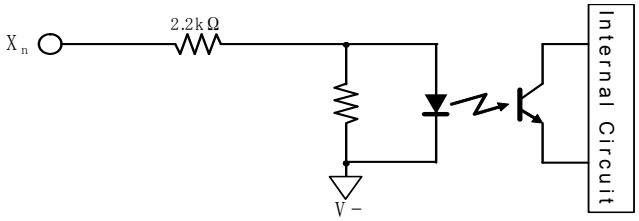
Note1. The drive port generates check pulses in order to diagnose input devices and internal circuits. (Wiring and the diagnostic function are different depending on the logic selected. See “Chapter 5 LOGIC” for details. But the basic function is same.)

Note2. For cables longer than 30m between SG-ONE and connected devices, or wiring drive terminals and receive terminals separately, use grounded shielded cables to assure electromagnetic compatibility.

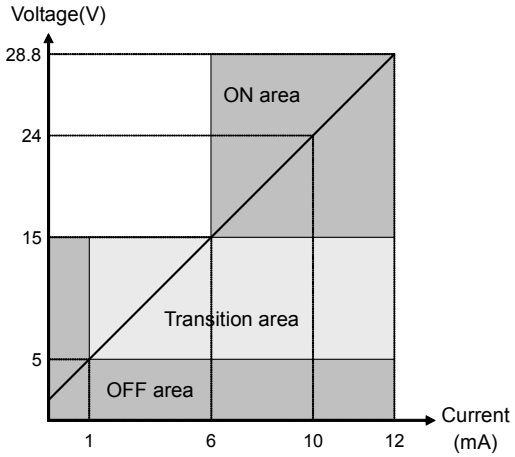
In case of multiple safety input devices are connected




Safety input equivalent circuit




Safety input operating range

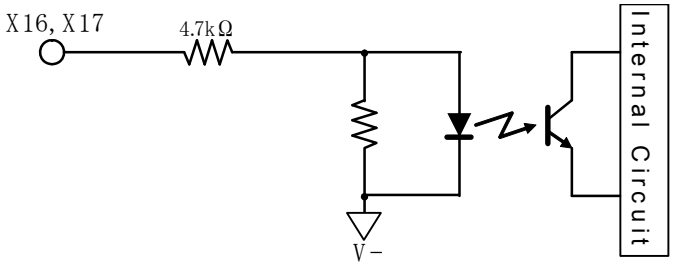


## Start input specifications

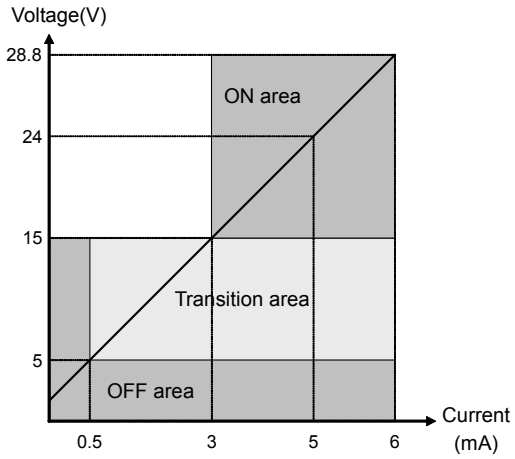
| | |
|---|---|
| Rated input voltage | 24V DC |
| Input ON voltage | 15.0V DC to 28.8V DC |
| Input OFF voltage | Open or 0V DC to 5.0V DC |
| Number of start input terminals | 2 (X16,17) |
| Input current | 5mA per port (at rated voltage) |
| Type of input | Sink type input (for PNP output), Type 1 (IEC/EN61131-2) |
| Cable length[Note1] | 100m maximum (total wiring length per 1 input) |
| Allowable wiring resistance | 300Ω maximum |

Note1. For cables longer than 30m between SG-ONE and connected devices, use grounded shielded cables to assure electromagnetic compatibility.

Start input equivalent circuit




Start input operating range




Operating specification of start inputs are different depending on the configured logic number. For more details, refer to “Chapter 5 LOGIC”. But the basic input specifications are not changed.

**Warning**

Do not use start inputs as safety inputs. This may cause the loss of safety functions and possible failure in the SG-ONE or peripherals.

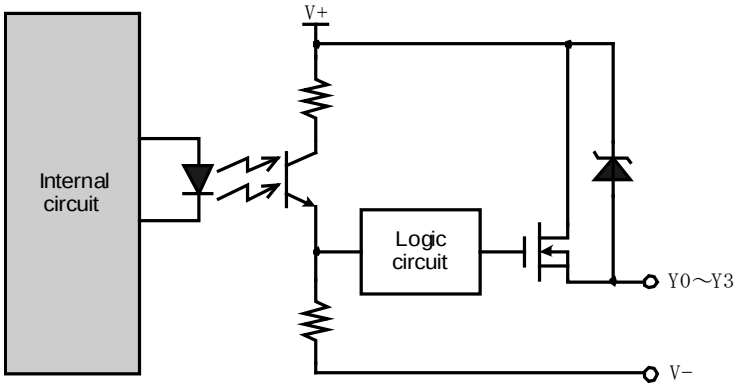
## Safety output specifications

| | | |
|---|---|---|
| Output type | | Source output (N channel MOSFET) |
| Rated output voltage | | Power supply voltage |
| Minimum voltage | | Power supply voltage - 2.0V |
| Number of output terminals | | 4（Y0, Y1, Y2, Y3） |
| Maximum output current | Point | 500mA maximum |
| | total | 1A maximum |
| Leakage current | | 0.1mA maximum |
| Allowable inductive Load Note1 | | L/R=25ms |
| Allowable capacitive load | | 1uF maximum |
| Cable length Note2 | | 100m maximum (total wiring length per 1 output) |

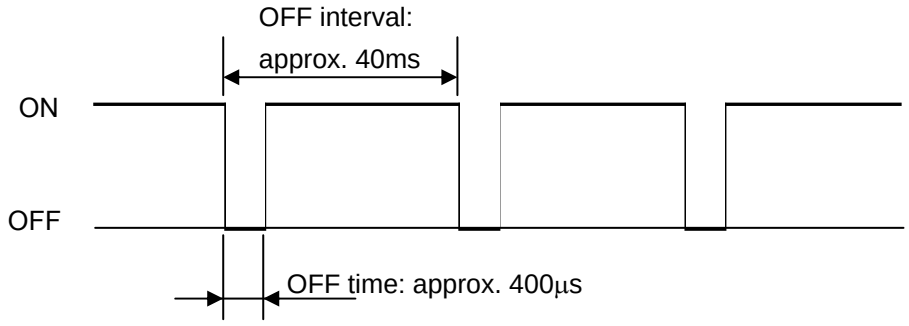
Note1. For protection of output circuits, protection devices such as diode should be connected to output circuits with inductive loads.

Note2. For cables longer than 30m between SG-ONE and connected devices, use grounded shielded cables to assure electromagnetic compatibility.

Safety output equivalent circuit




Safety outputs of the SG-ONE are semiconductor outputs. For diagnostics of the shut-off function, the SG-ONE generates off-pulses in certain intervals when the outputs are in ON state. The specifications of the safety outputs changes depending on the Logic selected. See further information in “Chapter 5 LOGIC”. But the basic specifications are same.




**Caution**

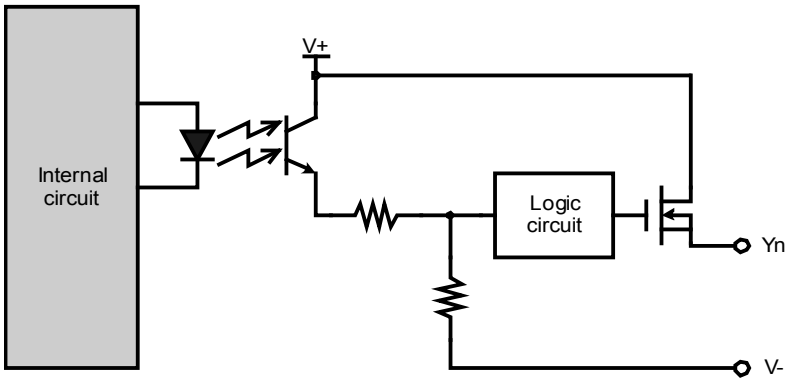
Check the response time of external devices so that they do not correspond to the off pulses. Monitor and solenoid/lamp outputs do not generate off pulses.

## Monitor output specifications

| | | |
|---|---|---|
| Output type | | Source output (N channel MOSFET) |
| Rated output voltage | | Power supply voltage |
| Minimum output voltage | | Power supply voltage - 2.0V |
| Number of outputs | | 11 (Y4, Y5, Y6, Y7, Y10, Y11, Y12, Y13, Y14, Y15, Y16) |
| Maximum output current | Point | 20mA maximum |
| | total | 220mA maximum |
| Leakage current | | 0.1mA maximum |
| Cable length[Note1] | | 100m maximum (total wiring length per 1output) |

Note1. For cables longer than 30m between SG-ONE and connected devices, use grounded shielded cables to assure electromagnetic compatibility.

Monitor output equivalent circuit




The specifications of the monitor outputs changes depending on the Logic selected. See further information in “Chapter 5 LOGIC”. The basic specifications are the same.

**Warning**

Do not use monitor outputs for safety related purposes. This may cause a loss of safety functions in case of failure of the SG-ONE or peripherals.

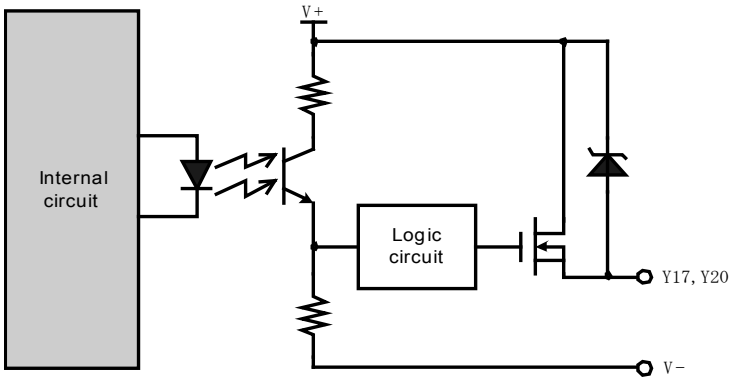
## Solenoid/Lamp output specifications

| | | |
|---|---|---|
| Output type | | Source output (N channel MOSFET) |
| Rated output voltage | | Power supply voltage |
| Minimum output voltage | | Power supply voltage - 2.0V |
| Number of outputs | | 2 （Y17, Y20） |
| Maximum output current | point | 500mA maximum |
| | total | 500mA maximum |
| Leakage current | | 0.1mA maximum |
| Allowable Inductive Load Note1 | | L/R=25ms |
| Cable length Note2 | | 100m maximum (total wiring length per 1 output) |

Note1. For protection of output circuits, protection devices such as diodes should be connected to output circuits with inductive loads.

Note2. For cables longer than 30m between SG-ONE and connected devices, use grounded shielded cables to assure electromagnetic compatibility.

Solenoid/lamp output equivalent circuit

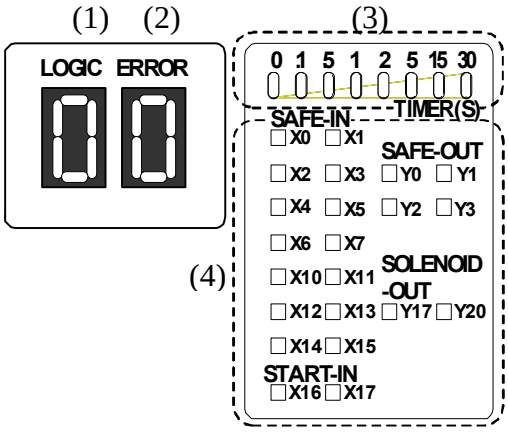



The specifications of the Solenoid/Lamp outputs changes depending on the Logic selected. See further information in “Chapter 5 Logic”. But the basic specifications are the same.

**Warning**

Do not use solenoid/lamp outputs for safety related purposes. This may cause a loss of safety functions in case of failure of the SG-ONE or peripherals.

## Indicators




(1) Logic LED (green)
(2) Error LED (red)
(3) Timer LED (green)
(4) Input/Output status LED (orange)

- SAFE-IN
- START-IN
- SAFE-OUT

**(1) Logic LED**

| Indication | Status | Descriptions |
|---|---|---|
| "1"... "8" | ON | The selected logic is in Run or Protection state. |
| | Blink | The selected logic is in Configuration state. |
| "E" | Blink | The selected logic has Configuration error (The logic is not selected or more than one logic is selected.) |
| Random pattern | ON/Blink | Initializing (Initial state) |
| Blank | OFF | Error (stop state) |

**(2) Error LED**

| Indication | Status | Descriptions |
|---|---|---|
| "1" | ON | Input monitor error (Protection state) |
| "2" | ON | Wiring error at safety inputs or error in safety input circuits |
| "3" | ON | Wiring error at start inputs or error in start input circuits |
| "4" | ON | Wiring error at safety outputs or error in safety output circuits |
| "5" | ON | Muting lamp error (disconnection) (Logic4 only) |
| "6" | ON | Power supply error or internal power supply circuit error |
| "7" | ON | Internal error, power supply error or internal power supply circuit error |
| "9" | ON | EMC disturbance |
| "C" | ON | Configuration procedure is in progress (Configuration state) |
| | Blink | Configuration is valid [Note] (Configuration state) |
| Random | ON/Blink | Initializing (Initial state) |
| Blank | OFF | Normal operation (Run state) |

Note. Blinks for 1 to 5 seconds after the enter button is pressed. Releasing the button during blinking activates the setting. The blinking LED becomes ON if the button is pressed for more than 5 seconds, and the setting becomes invalid even after the button is released.

**(3) Timer LED**

| Indication | Status | Descriptions |
|---|---|---|
| 0 | ON | No OFF-delay (safety outputs shut off immediately) |
| .1 | ON | OFF-delay timer 0.1s |
| .5 | ON | OFF-delay timer 0.5s |
| 1 | ON | OFF-delay timer 1s |
| 2 | ON | OFF-delay timer 2s |
| 5 | ON | OFF-delay timer 5s |
| 15 | ON | OFF-delay timer 15s |
| 30 | ON | OFF-delay timer 30s |
| Each LED | Blink | Selected timer value (Configuration state) |
| Random | ON/Blink | Initializing (Initial state) |
| Blank | OFF | Timer value is not selected or SG-ONE is in the Stop state |

**(4) Input LED： SAFE-IN (X0 … X15), START-IN (X16, X17)**

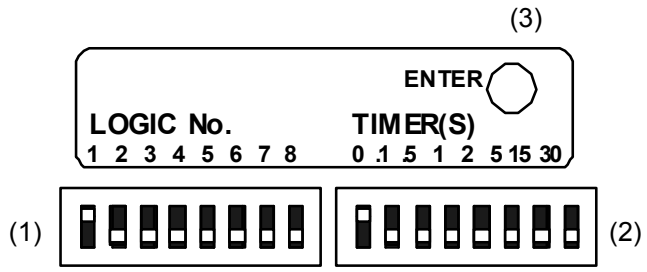
| Indication | Status | Descriptions |
|---|---|---|
| X0 to X15 | ON | Input ON |
| | OFF | Input OFF, or SG-ONE is in the Stop or Configuration state |
| | Blink | Input monitor error |
| X16, X17 | ON | Input ON |
| | OFF | Input OFF, or SG-ONE is in the Stop or Configuration state |

Indicators specification of input LEDs are different depending on the selected logic.

(5) **Output LED: SAFE-OUT (Y0 … Y3), SOLENOID-OUT (Y17, Y20)**

| Indication | Status | Descriptions |
|---|---|---|
| Y0 to Y3 | ON | Output ON |
| | OFF | Output OFF, or SG-ONE is in the Stop or Configuration state |
| | Blink | During OFF-delay timer operation |
| Y17, Y20 | ON | Output ON |
| | OFF | Output OFF, or SG-ONE is in the Stop or Configuration state |

## Specification of configuration switches




(1) Logic switch
(2) Timer switch
(3) Enter button

**(1) Logic switch**

The logic switch is an 8-digit DIP switch for use in logic configuration. When one of 8 digits is selected, the corresponding logic in the SG-ONE is activated. See “Chapter 5 Logic” for further information of each logic. The upper position of each digit is the ON state. **Multiple switches must not be selected.**

**(2) Timer switch**

The timer switch is an 8-digit DIP switch for use in OFF-delay timer value configuration. When one of 8 digits is selected, the delay time at shut-off operation is activated. The upper position of each digit is ON state. **Multiple switches must not be selected.**

| Switch | (Indication) | Descriptions |
|---|---|---|
| 0 | 1 | No OFF-delay (safety outputs shut OFF immediately) |
| .1 | 2 | OFF-delay timer 0.1s |
| .5 | 3 | OFF-delay timer 0.5s |
| 1 | 4 | OFF-delay timer 1s |
| 2 | 5 | OFF-delay timer 2s |
| 5 | 6 | OFF-delay timer 5s |
| 15 | 7 | OFF-delay timer 15s |
| 30 | 8 | OFF-delay timer 30s |

**(3) Enter button**

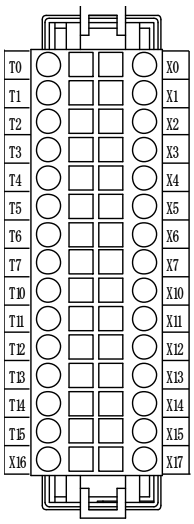
The enter button is used to activate the configuration of logic and timer value. Error LED will blink for 1 to 5 seconds after pressing the enter button. Releasing the button during blinking activates the setting. The blinking LED becomes ON if the button is pressed for more than 5 seconds, and the setting becomes invalid even after the button is released.

**Caution**

For setting the swithes and enter button, use the configuration tool supplied with the SG-ONE.

# Connector specifications

■Input connector

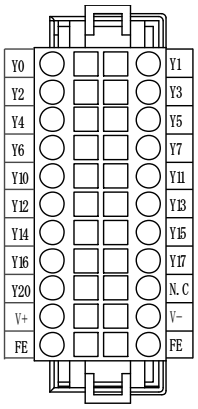



Connector type: - Spring clamp connector (30 poles)
(Tyco Electronics AMP type Number: 2-1871940-5)
- Crimp connector (30 poles)[Note1]
(Tyco Electronics AMP type Number: 2-1871946-5)

| Terminal name | Terminal No. | Descriptions | Terminal name | Terminal No. | Descriptions |
|---|---|---|---|---|---|
| T0 | A1 | Safety input drive terminal 0 | X0 | B1 | Safety input receive terminal 0 |
| T1 | A2 | Safety input drive terminal 1 | X1 | B2 | Safety input receive terminal 1 |
| T2 | A3 | Safety input drive terminal 2 | X2 | B3 | Safety input receive terminal 2 |
| T3 | A4 | Safety input drive terminal 3 | X3 | B4 | Safety input receive terminal 3 |
| T4 | A5 | Safety input drive terminal 4 | X4 | B5 | Safety input receive terminal 4 |
| T5 | A6 | Safety input drive terminal 5 | X5 | B6 | Safety input receive terminal 5 |
| T6 | A7 | Safety input drive terminal 6 | X6 | B7 | Safety input receive terminal 6 |
| T7 | A8 | Safety input drive terminal 7 | X7 | B8 | Safety input receive terminal 7 |
| T10 | A9 | Safety input drive terminal 10 | X10 | B9 | Safety input receive terminal 10 |
| T11 | A10 | Safety input drive terminal 11 | X11 | B10 | Safety input receive terminal 11 |
| T12 | A11 | Safety input drive terminal 12 | X12 | B11 | Safety input receive terminal 12 |
| T13 | A12 | Safety input drive terminal 13 | X13 | B12 | Safety input receive terminal 13 |
| T14 | A13 | Safety input drive terminal 14 | X14 | B13 | Safety input receive terminal 14 |
| T15 | A14 | Safety input drive terminal 15 | X15 | B14 | Safety input receive terminal 15 |
| X16 | A15 | Start input terminal 16 | X17 | B15 | Start input terminal 17 |

Note1. For detailed information of Crimp connector, consult Tyco Electronics AMP.

■Output connector




Connector type: - Spring Clamp connector (22 poles)
(Tyco Electronics AMP type No.:2-1871940-1)
- Crimp connector (22 poles)
(Tyco Electronics AMP type No.: 2-1871946-1)

| Terminal name | Terminal No. | description | Terminal name | Terminal No. | Description |
|---|---|---|---|---|---|
| Y0 | A1 | Safety output terminal 0 | Y1 | B1 | Safety output terminal 1 |
| Y2 | A2 | Safety output terminal 2 | Y3 | B2 | Safety output terminal 3 |
| Y4 | A3 | Monitor output terminal 4 | Y5 | B3 | Monitor output terminal 5 |
| Y6 | A4 | Monitor output terminal 6 | Y7 | B4 | Monitor output terminal 7 |
| Y10 | A5 | Monitor output terminal 10 | Y11 | B5 | Monitor output terminal 11 |
| Y12 | A6 | Monitor output terminal 12 | Y13 | B6 | Monitor output terminal 13 |
| Y14 | A7 | Monitor output terminal 14 | Y15 | B7 | Monitor output terminal 15 |
| Y16 | A8 | Monitor output terminal 16 | Y17 | B8 | Solenoid/lamp output terminal 17 |
| Y20 | A9 | Solenoid/lamp output terminal 20 | N.C | B9 | No connection terminal |
| V+ | A10 | Power supply 24VDC terminal | V- | B10 | Power supply 0VDC terminal |
| FE | A11 | Functional Earth terminal | FE | B11 | Functional Earth terminal |

Note1. For detailed information of the Crimp type connector, consult Tyco Electronics AMP.

# Chapter3 INSTALLATION AND WIRING

This chapter describes methods and precautions for installing and wiring the SG-ONE. Before starting installation and wiring, be sure to read “SAFETY PRECAUTIONS” in the beginning of this manual and understand the precautions described under WARNING and CAUTION.

**Warning**

- Turn off power to SG-ONE before starting installation, removing, wiring, maintenance, or inspection of SG-ONE. Failure to turn power off may cause electrical shocks or fire hazard.
- Before operating SG-ONE, carefully read the instruction sheet and this manual, and ensure that the environment conforms to the requirements of SG-ONE specifications. If SG-ONE is operated in an environment that exceeds the specifications of SG-ONE, it causes impairment of the safe operation of SG-ONE.
- . The installation, wiring, configuration, and operation of SG-ONE must be performed only by “Safety responsible personnel”. Safety responsible personnel are personnel who have requisite qualifications as being capable of safely carrying out each step, including designing, installation, operation, maintenance, and disposal of SG-ONE. Personnel without the technical expertise of the safety responsible personnel must not use SG-ONE.
- Installation of SG-ONE must be performed according to the instructions found in the instruction sheet and this manual. Improper installation may cause the SG-ONE to fail.
- Use a power supply that meets following required specifications:
  -Conforms to the power supply rating of SG-ONE
  -The primary and secondary circuits are separated by double insulation or reinforced insulation.
  -Has the functionality or the functional equivalent of the control voltage and current of a class 2 circuit, as defined in UL 508 or UL 1310.
  -Is in compliance with safety laws and regulations relating to electrical safety, and EMC, under the laws and regulations of the country in which it is being used.
- Ground the V-line (0V DC) for ground fault diagnosis.
- In the case of a new configuration or modified installation, be sure to perform a check for each input and output function.
- Separate SG-ONE from devices and wires which are not according to class 2 circuit requirements.

**Caution**

- SG-ONE is designed for installation in an enclosure. Do not install SG-ONE outside an enclosure. Install SG-ONE in enclosure with a rating of IP54 or higher.
- Install SG-ONE in environments described in the catalog, instruction sheet, and user’s manual. If SG-ONE is used in places where the SG-ONE is subjected to high temperature, high humidity, condensation, corrosive gases, excessive vibrations, and excessive shocks, then electrical shocks, fire hazard, or malfunction may result.
- Environment for using the SG-ONE is “Pollution degree 2”. Use SG-ONE in environments of pollution degree 2 (according to IEC/EN 60664-1).

- Prevent SG-ONE from falling while moving or transporting the SG-ONE, otherwise damage or malfunction of the SG-ONE may result.
- Prevent metal fragments and pieces of wire from dropping inside the SG-ONE housing.
- Install SG-ONE, so that there is adequate spacing from walls, heat generating bodies, and peripherals, taking into consideration space requirements for maintenance and ventilation.
- Install SG-ONE on 35mm DIN rails with BNL6 mounting clips (sold separately) on both sides of SG-ONE.
- Perform wiring to the connectors with proper cables or ferrules.
- Ground FE terminal to assure electromagnetic compatibility (EMC)
- Use common 0V DC, if different power supplies are used for SG-ONE and other devices (ex. safety light curtains).
- Install wiring for the inputs and outputs so that it is separated from power lines.

# Installation method

## ■ Installation location and direction

When the SG-ONE is installed in an enclosure, confirm that installation environments meet the product specifications. Using in environments such as a described below, (over the product specifications) may cause fire hazard, damage, or malfunction.

・SG-ONE should not be exposed to excessive dust, dirt, salt, vibration or shocks.
・Do not use SG-ONE in an area where corrosive chemicals or flammable gases are present.
・Do not use SG-ONE nearby induction heat source

Mount SG-ONE with enough space from any device as shown at Fig3.1 for maintenance and ventilation. Do not install SG-ONE near, and especially above, any heating device or heat source.

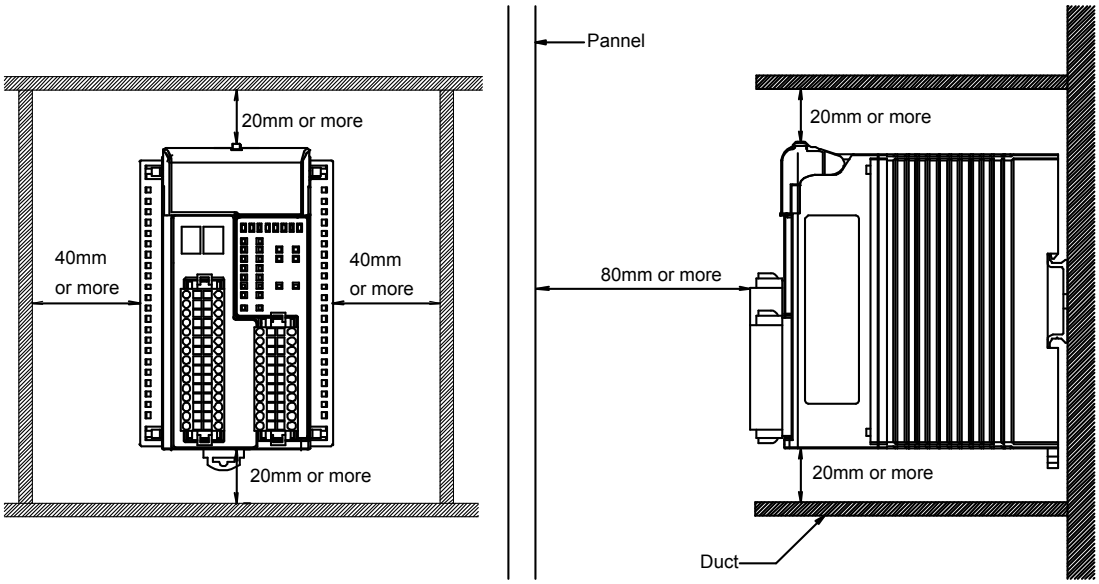



Fig. 3.1 Installation location

Mount SG-ONE on a vertical plane as shown in Fig.3.2.
All other installation directions are not allowed.

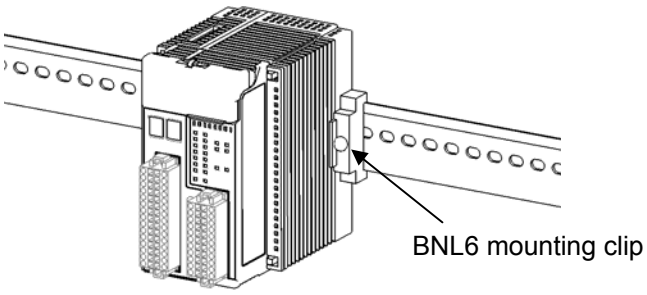



Fig. 3.2 Correct installation direction

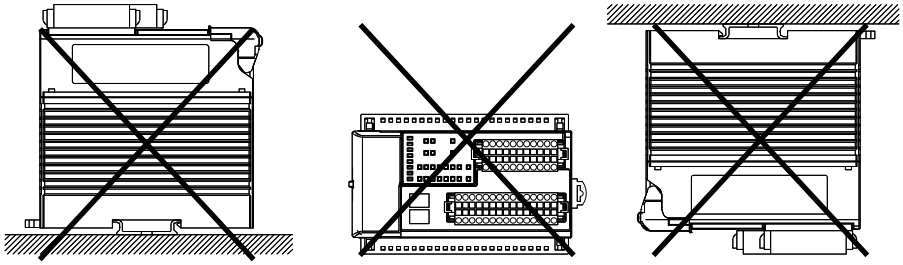



Fig. 3.3 Incorrect installation directions

## ■ Installing on DIN Rails

Mount and remove SG-ONE on 35mm-wide DIN rails according to the following instructions.

Mounting on DIN rail

1. Fasten DIN rail to a panel using screws.
2. With the top of SG-ONE unit facing up, as shown in Fig. 3.4, insert the groove, on the rear of the unit, and press the unit in the direction of the arrow.
3. Use BNL6 mounting clips (sold separately) on both sides of SG-ONE to prevent it from moving sideways.

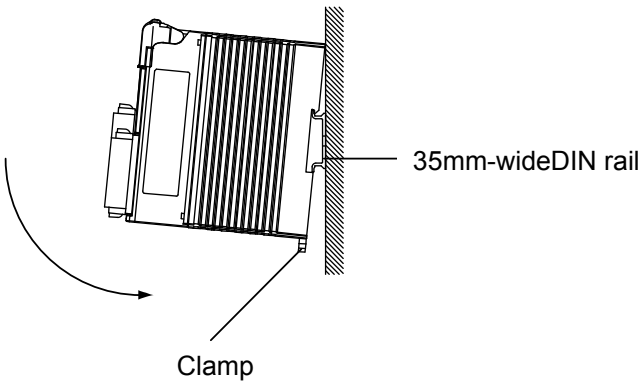



Fig. 3.4 Mounting

Removing from DIN Rail

1. Insert a flat screwdriver into the slot in the clamp.
2. Pull the clamp until you hear a click, as shown in Fig. 3.5.
3. Remove SG-ONE bottom out.

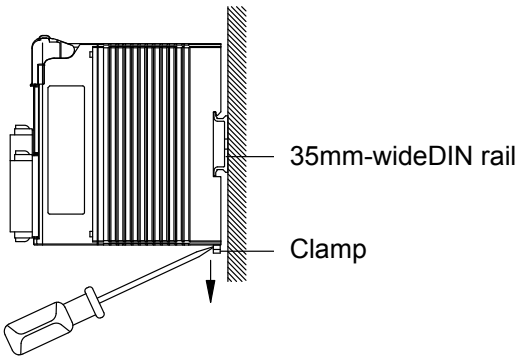



Fig. 3.5 Removing

## Wiring method

SG-ONE has to two kinds of connectors = spring clamp = (optional) and crimp.[Note1]

Note1. For detailed information of Crimp connector, consult Tyco Electronics AMP.

●Applicable connectors and mounting to SG-ONE

Applicable connectors

| Type | No. of pole | Part No. | Remarks |
|---|---|---|---|
| Spring clamp | 30 | 2-1871940-5 | Tyco Electronics AMP |
| | 22 | 2-1871940-1 | Tyco Electronics AMP |
| Crimp | 30 | 2-1871946-5 | Tyco Electronics AMP |
| | 22 | 2-1871946-1 | Tyco Electronics AMP |

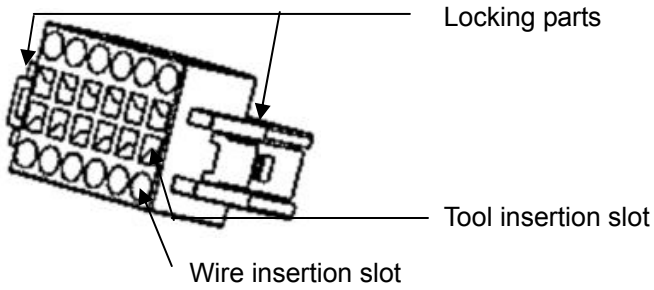



Fig. 3.6 Spring clamp connector

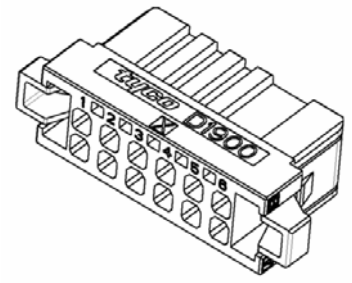


Fig. 3.7 Clamp connector

When mounting a connector to the SG-ONE, be sure to insert the connector straight and completely in until you hear a click or feel it click into position. To remove the connector, press down on the lock completely, and then pull out the connector. If pressing down on the lock is incomplete damage to the connector and wire may occur.

● Applicable wire and ferrule sizes for Spring clamp connector

AWG#18-24 (UL1007 recommended) Stripped length: 7.0±0.3mm

When using ferrules, specification are shown below.

Long size: 1.02mm (min.) - 1.21mm (max.) (”a” in the figure below)

Short size: 0.95mm (min.) - 1.21mm (max.) (”b” in the figure below)

Applicable wire: AWG#24 (UL1007 recommended)

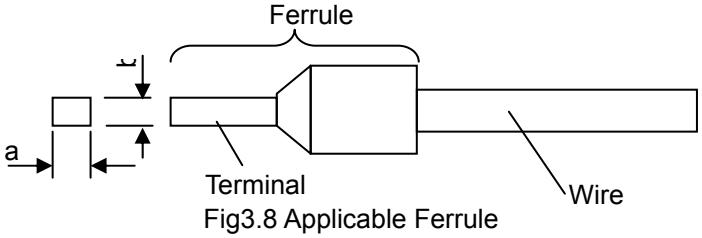



Fig3.8 Applicable Ferrule

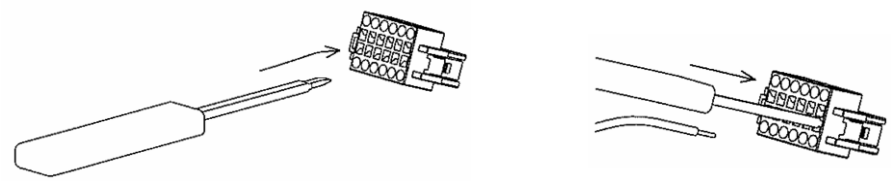
**● Wiring for spring connector**

Do not wire the connector while it is connected to the SG-ONE, as this can damage the connector and the SG-ONE.

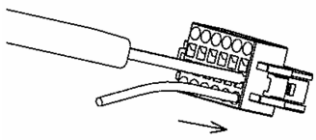
To connect the wire, use a commercially-available screwdriver. It is recommended that you use a dedicated connecting tool to prevent any scratches or damage to the connector housing and spring. When rewiring, use wire with same gauge.

● Wiring with a connecting tool

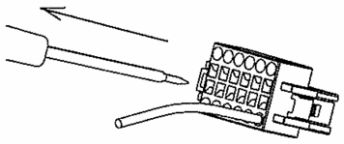
1. Insert the connecting tool into the tool insertion slot on the connector at an angle until the tool comes to a stop.



2. Insert the wire into wire insertion slot. (If there are any loose strands, twist the wire to make it even.)



3. With the wire pressed down, remove the connecting tool to finish the wiring. Lightly tug on the wire to check that it is securely connected.



4. To remove the wire, press down the spring with the connecting tool, as if you are connecting the wire, and pull out the wire.

● Wiring with a commercially-available screwdriver

Use a screwdriver with a tip width that does not exceed 2.4 mm. Be careful when wiring with a screwdriver as this can damage the connector.

1. Insert the screwdriver into the tool insertion slot on the connector at an angle, and press down so as to open the spring. Be careful not to insert the screwdriver with too much force, as this can damage the connector. Do not insert the screwdriver into the wire insertion slot.
2. With the screwdriver inserted, as described in Step 1 above, insert the wire into wire insertion slot. (If there are any loose strands, twist the wire to make it even.)
3. With the wire pressed down, remove the screwdriver to finish the wiring. Lightly tug on the wire to check that it is securely connected.
4. To remove the wire, press down the spring with the screwdriver, as if you are connecting the wire, and pull out the wire.

# Chapter4 BASIC OPERATIONS

This chapter describes the basic operations of SG-ONE. Make proper use of the SG-ONE by thoroughly familiarizing yourself with the basic operations and functions.

**Internal states**

The SG-ONE operates in five internal states, as shown in Table 4.1.

The LED display and output status for each state are shown in Table 4.2.

Table 4.1 Internal states

| State | Description |
|---|---|
| Initial | This is the state during which initial processing is performed immediately after power is supplied to SG-ONE. During this state, the internal circuits are checked and the LED displays and lights indicate operation confirmation (blinking) for about 6s. |
| Run | This is the state during which the SG-ONE operates normally. Logic processing continues without failures or wiring errors. (Refer to "Chapter 5 LOGIC" for details.) |
| Configuration | This is the state for configuring the logic and OFF-delay timer values.<br>Executing the determined configuration procedure enables the desired logic and OFF-delay timer value and restores the SG-ONE to the Run state. (Refer to "Logic configuration" and "Timer configuration" in this chapter for details.) |
| Protection | The SG-ONE transitions to this state when there is input monitor error in the dual channel input, EDM input or muting input. After the cause that generated the Protection state is removed, the unit is restored to the Run state. (Refer to "Canceling the Protection state" in this chapter for details.) |
| Stop | The SG-ONE transitions to this state when a failure or other error occurs in an external device or internal circuit. After the cause that generated the Stop state is removed, the Stop state can be canceled by restarting the SG-ONE (power on again). (Refer to "Canceling the Stop state" in this chapter for details.) |

Table 4.2 LED display and output status for each state

| State | Logic LED | Error LED | Timer LED | Safety output | Solenoid/ lamp output | Monitor output | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Y0…Y3 | Y17,Y20 | Y4…Y13 | Y14 | Y15 | Y16 |
| Initial | (1) | (1) | (1) | □OFF | □OFF | □OFF | ■ON | ■ON | □OFF |
| Run | Selected number | Blank | Selected number | (2) | (2) | (2) | □OFF | □OFF | ■ON |
| Configuration | (3) | “C” | (3) | □OFF | □OFF | □OFF | □OFF | ■ON | □OFF |
| Protection | Selected Number | “1” | Selected number | □OFF | □OFF | (4) | □OFF | ■ON | □OFF |
| Stop | Blank | (5) | Blank | □OFF | □OFF | □OFF | ■ON | ■ON or □OFF | □OFF |

(1) Random display in Initial state

(2) LED display and outputs corresponding to selected logic

(3) Blinking display of selected logic number and timer value LED

(4) The input LEDs and monitor outputs corresponding to the input which occurred before the error become pulse output. For the other LEDs and monitor outputs, the LED indications and monitor outputs are kept from just before the Run state.

(5) Display the error number occurred.

Refer “Chapter2 PRODUCT SPECIFICATIONS” for detail information of LED display.

**Caution**

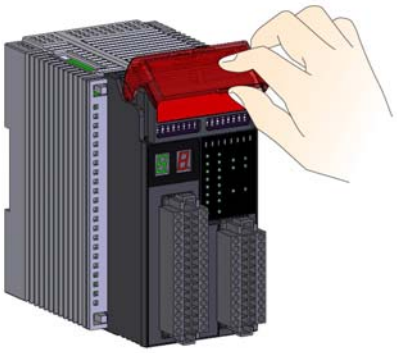
When the state changes to the Run state from another state, solenoid/lamp outputs (Y17, Y20) are turned ON for 1s maximum. Be wary of the behavior of connected devices.

## Turning on the power

After the SG-ONE is turned on, SG-ONE transitions to the Initial state and checks the internal circuits. SG-ONE changes to the appropriate state (in approximately 6s) according to the result of the internal circuit check. During the Initial state, the LEDs blink to check operation.

Logic switch and timer switch are set Logic: “1” and Timer: “1 (0s)” at the factory. When initially powering up the SG-ONE, thoroughly confirm the configuration and the operation.

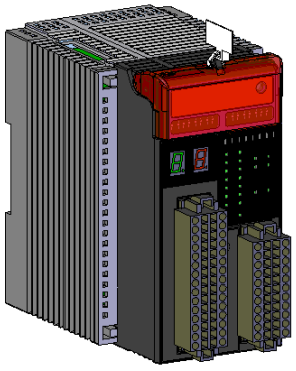
## Using the protective cover



**●Opening and closing the protective cover**

Place your finger at the bottom right of the protective cover, and open the cover to a position that enables you to view the configuration options. The protective cover can be set at two opened positions (60° or 120°). Be careful not to open the cover beyond 120°, as this causes the cover to separate from the body.

**●Locking the protective cover**



After configuration of SG-ONE and confirming, close and the protective cover. To protect the configuration, it is recommended that the protective cover be locked.

Use the attached marking tie or commercially-available wire or a similar equipment to lock the protective cover. In case of using commercially-available wire, use wire that personal, other than safety responsible persons operating the SG-ONE, are not able to modify its configuration. (ex. $\phi$1.0 or more metal wire)

The protective cover and marking tie do not ensure mechanical strength against strong force. The protective cover and marking tie can be broken with the strong force.

# Logic configuration

The SG-ONE offers 8 types of logic, and by performing the logic configuration procedure listed below, you can enable the desired logic.
The SG-ONE can transition to the Configuration state from the Run or Protection state.
Configuration operations are disabled in the Initial and Stop states.
Once any logic is configured, it is kept in the SG-ONE even if the power is turned off.
The logic and timer settings can be configured at the same time. Confirm the configuration methods, and configure the logic and timer properly.
The logic switch is set “1” at the factory. When initially powering on the SG-ONE, thoroughly confirm the configuration and the operation.

**1. Open the protective cover**.
Open the cover to a position that enables you to set the configuration operations.
Refer to "Using the protective cover" for details.

**2. Select the logic switch.**
Select and operate the logic switch. When operating the logic switch, use the attached configuration tool.
When the logic configuration is changed, "C" is displayed in the error LED display and the new number of the logic configuration blinks in the logic LED display.
If any logic switch is not selected or multiple logic switches are selected, "E" is displayed in the logic LED display.

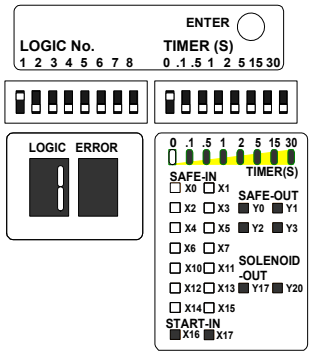



Fig. 4.1 Normally switch configuration and LED indication (Run state)

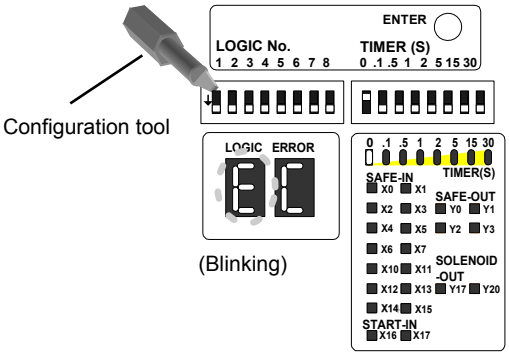



Fig. 4.2 Logic switch is not selected (Configuration state)

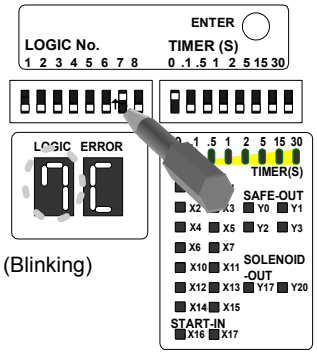


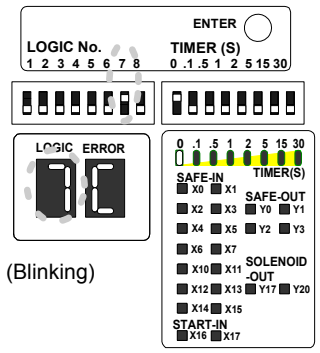

Fig. 4.3 Logic number “7” is selected (Configuration state)

**3. Confirm the configuration and press the enter button.**

Confirm that the selected logic switch matches the blinking logic LED, and then press the enter button by using configuration tool.

Be sure to confirm that they match. If the switch configuration and display do not match and you press the enter button, unintended logic may be activated.

Press and hold the enter button for 1 to 5s to enable the configuration. "C" blinks in the error LED display while you press the enter button. If you press the enter button for less than 1s or more than 5s, the logic is not activated.




(Blinking)

Fig. 4.4 Confirmation of logic switch configuration and LED indication (Configuration state)

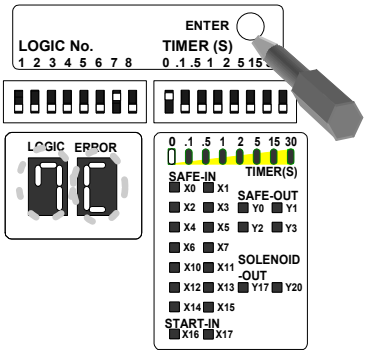



Fig. 4.5 LED indication during enter button is valid (Configuration state)

**4. Confirm that the logic is activated.**

The logic LED display changes from a blinking display to solid display, the error LED turns off, and the selected logic is activated.

After configuring the logic, be sure to confirm that the selected logic is activated.

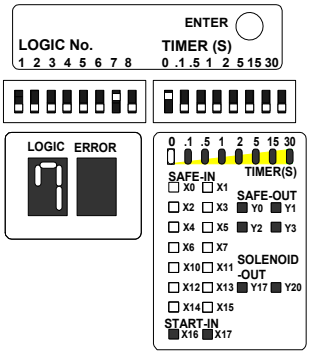



Fig. 4.6 Completion the configuration of Logic “7 “(Run state)

**5. Lock the protective cover.**

Close and lock the protective cover.

Refer to "Using the protective cover" in this chapter for details. To protect the configuration setting, it is recommended that the protective cover be locked.

## Timer configuration

SG-ONE has an OFF-delay timer function that retains the safety outputs during the configured time and after that turns OFF the safety outputs. You can use this function to configure stop category "0" or "1". Perform the configuration procedure listed below to configure the OFF-delay timer to one of the following eight settings, using the same procedure as that for configuring the logic:
0, 0.1, 0.5, 1, 2, 5, 15, or 30 s.

Configuration operations are disabled in the Initial and Stop states.
Once any timer value is configured, it is kept in the SG-ONE even if the power is turned off.
Logic and timer settings can be configured at the same time. Confirm the configuration methods, and configure the logic and timer properly.
The timer switch is set “1(0s)” at the factory. When initially powering on the SG-ONE, thoroughly confirm the configuration and the operation.

**1. Open the protective cover.**
Open the cover to a position that enables you to set configuration operations.
Refer to "Using the protective cover" for details.

**2. Select the timer switch.**
Select and operate a timer switch. When operating a timer switch, use the configuration tool.
When the timer configuration is changed, "C" is displayed in the error LED display and the timer LED light that corresponds to the selected timer configuration switch blinks.

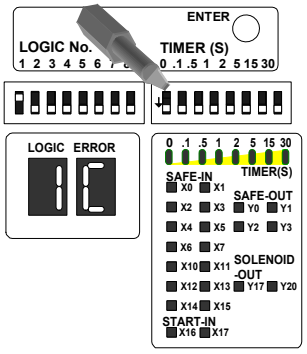



Fig. 4.7 Timer switch is not selected (Configuration state)

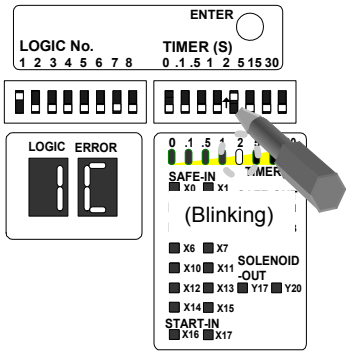



Fig. 4.8 OFF-delay timer value “2s” is selected (Configuration state)

**3. Confirm the configuration and press the enter button.**

Confirm that the selected timer switch matches the blinking timer LED, and then press the enter button by using the configuration tool.

Be sure to confirm that they match. If the switch configuration and display do not match and you press the enter button, an unintended delay timer may be activated.

Press and hold the enter button for 1 to 5s to activate the configuration. "C" blinks in the error LED display while you press the enter button. If you press the enter button for less than 1s or more than 5s, the timer is not activated.

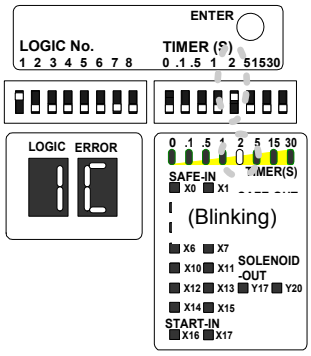



Fig. 4.9 Confirmation of timer switch configuration and LED indication (Configuration state)

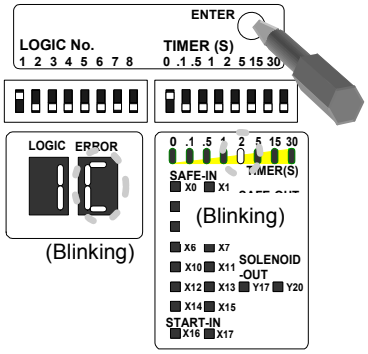



Fig. 4.10 LED indication during enter button is valid (Configuration state)

**4. Confirm that the timer is activated.**

The timer LED light changes from a blinking display to solid display, the error LED display turns off, and the selected timer value is activated. After configuring the timer, be sure to confirm that the selected timer value is activated.

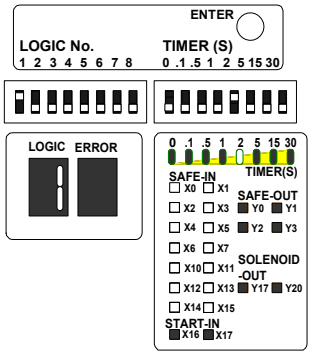



Fig. 4.11 Completion the configuration of OFF-delay timer value “2s“ (Run state)

**5. Close and lock the protective cover.**

Close and lock the protective cover.

Refer to "Using the protective cover" for details.

To protect the configuration setting, it is recommended that the protective cover be locked.

## Cancelling the Protection state

SG-ONE transitions to the Protection state if a failure is detected in an external device or an error is detected in external wiring, such as when different operations are performed between dual channel inputs or two muting inputs, or when the EDM input is OFF while the safety outputs are transitioning from OFF to ON by output control. In the Protection state, the safety outputs are turned OFF and a "1" is displayed in the error LED display. The Protection state can be cancelled by the following methods.

**• Cancellation by the connected control devices**

•In case of an error with the dual channel input, the Protection state is cancelled by turning OFF the appropriate dual channel input. (For example: Press an emergency stop switch or open a guard equipped with an interlock device.) But cancellation is only achieved during OFF-delay operation of safety outputs (Y0 to Y3).

•In case of an error with muting input (Logic 4 only), the Protection state is cancelled by turning OFF of the appropriate muting input. But cancellation is only achieved during OFF-delay operation of safety outputs (Y0 to Y3).

•In case of the error with mode select input (Logic 6 only), the Protection state is cancelled by turning OFF 1 of the appropriate 2 inputs. But the cancellation is only achieved during OFF-delay operation of safety outputs (Y0 to Y3).

•In case of an error with the EDM input, the Protection state is cancelled by turning ON the appropriate EDM input. When 1 of EDM inputs causes an error, the corresponded safety output is not turned ON, but the another safety output can be turned ON and after approximately 1s turned OFF. For the relationship between EDM inputs and safety outputs, refer Table 4.3 shown below.

Table 4.3 EDM inputs and corresponded safety outputs

| EDM inputs<br>(External Device Monitor inputs) | Safety outputs |
|---|---|
| T14-X14 | Y0, Y1 |
| T15-X15 | Y2, Y3 |

**• Cancellation by resetting power to SG-ONE**

The Protection state is cancelled by restart of power to SG-ONE after removing the error factor.

If the error factor that caused the change to the Protection state has been not removed, the unit returns to the Protection state again.

**• Cancellation by transition to Protection state**

By the changing the configuration of a logic or timer switch, the state changes from Protection state to Configuration state.

**Warning**

Turn OFF the power to SG-ONE before inspection and/or connecting of the wires.

## Canceling the Stop state

If the SG-ONE detects any wiring errors, abnormalities or internal circuit failure, it changes to the Stop state and locks out operations. The Stop state can be cancelled by the following method.

- **Cancellation by removal of power to SG-ONE**

The Stop state is cancelled by restart of power to SG-ONE after removing the error factor.

Refer "Chapter 6 TROUBLESHOOTING" for information to identify the cause that generated the Protection state or Stop state.

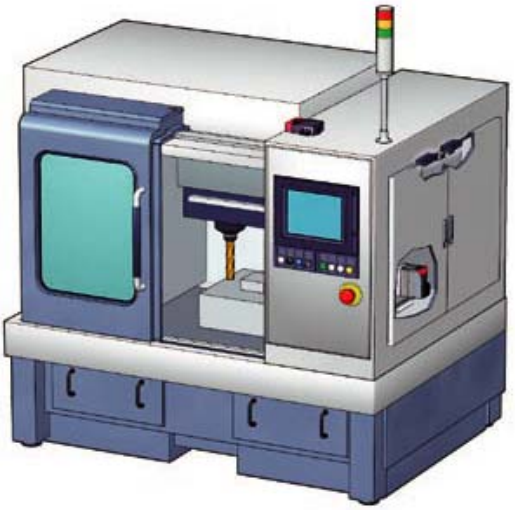
# Chapter5 LOGIC

This chapter describes the Logics in the SG-ONE. Make proper use of the SG-ONE by thoroughly familiarizing yourself with the basic operations and function of each Logic.

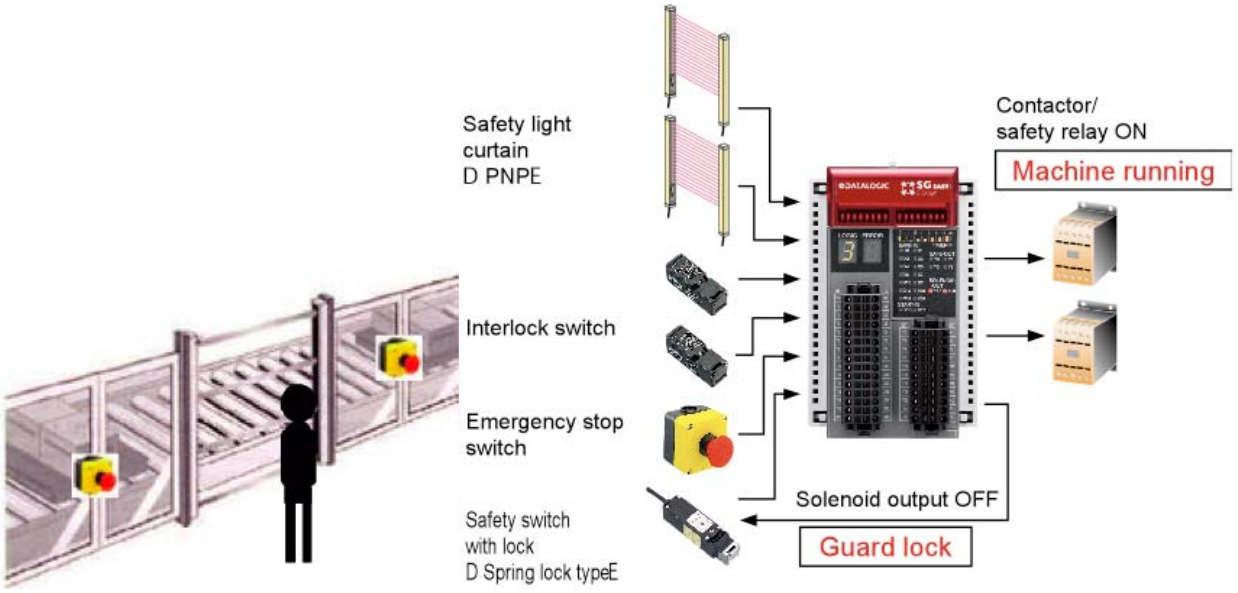
## Logic 1: General purpose logic for various apparatuses

### Overview (Logic 1)

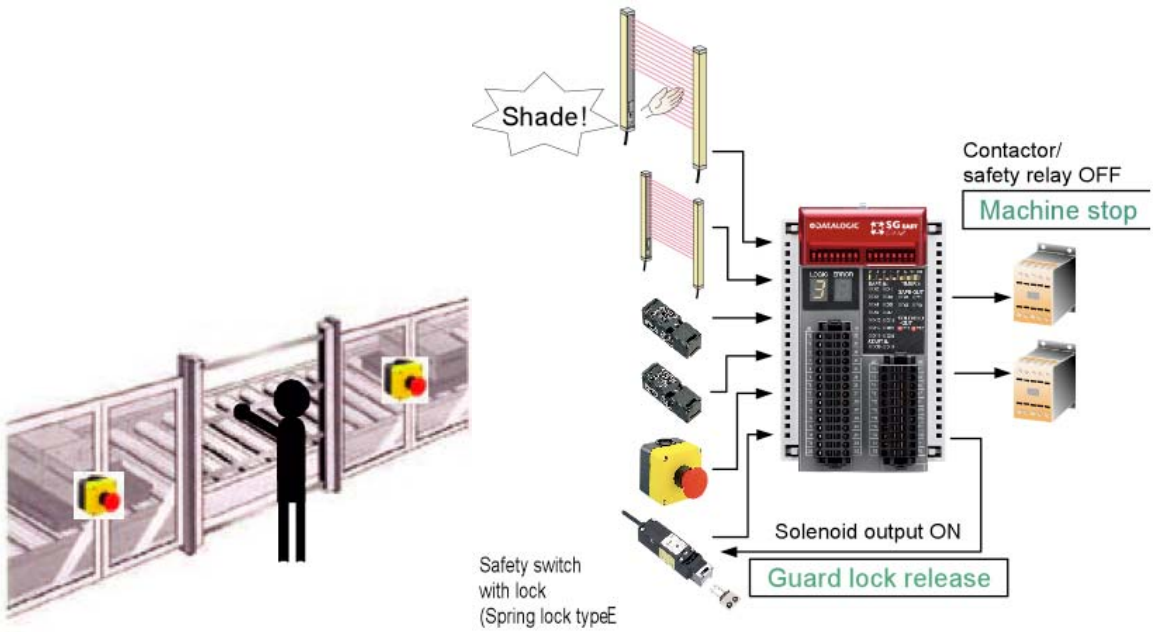
This logic is for safety protective measures applicable to production machines, robots, and other apparatuses. This logic enables the connection 6 dual channel direct opening inputs.
When SG-ONE is in the state which all of the safety inputs can receive the safety input signals (all contacts of the connected safety devices are ON), safety outputs are turned ON upon input of the start input. During the time the safety outputs are ON, if any safety input signal to any input of the safety inputs is turned OFF (the contacts of the safety devices are OFF), the safety outputs are turned OFF after the preset OFF-delay time.



## Operation example (Logic 1)

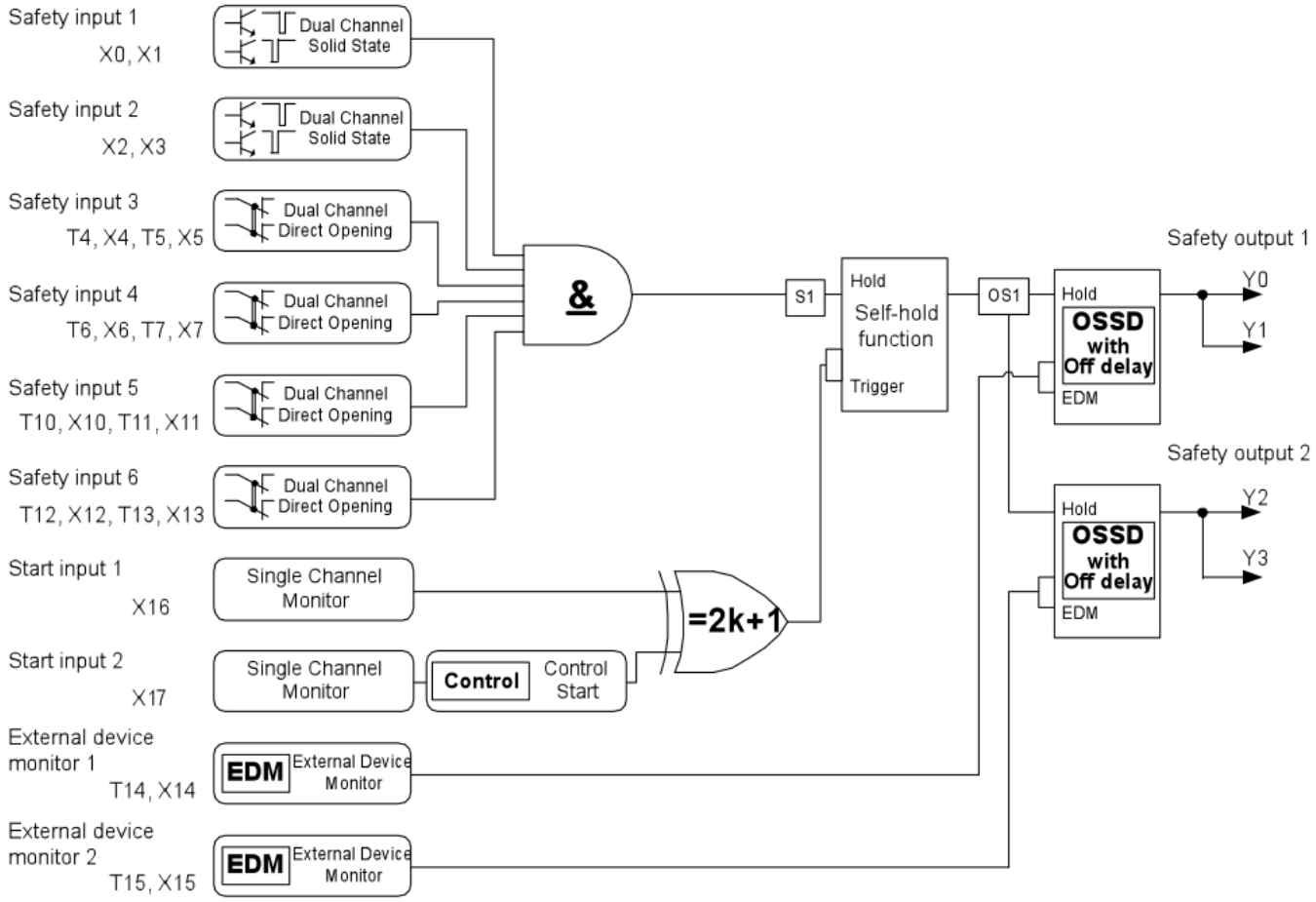



| | | |
|---|---|---|
| ・ All of emergency stop switches are released.<br>and<br>・ Movable guard is closed.<br>(All contacts of interlock switches are ON.) | ⇨ | ・ Start input is ON | ⇨ | ・ Safety outputs are ON. |

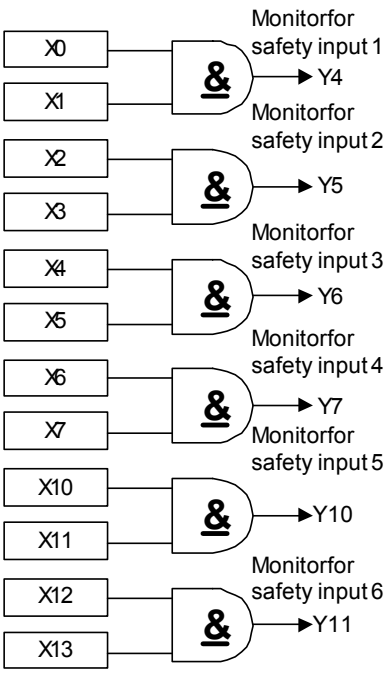



| | | |
|---|---|---|
| ・ Safety outputs are ON. | ⇨ | ・ Emergency stop switch is pressed.<br>or<br>・ Movable guard is opened.<br>(Contacts of interlock switch are opened.) | ⇨ | ・ Safety outputs are OFF.<br>・ Solenoid outputs are ON. |

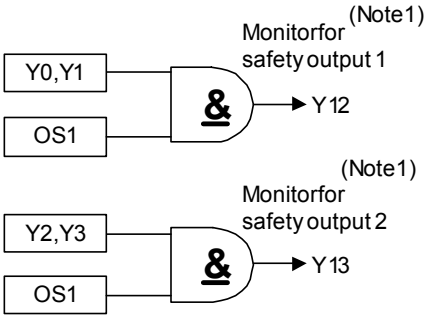
## Logic circuit (Logic 1)




### ●Monitor output for safety input

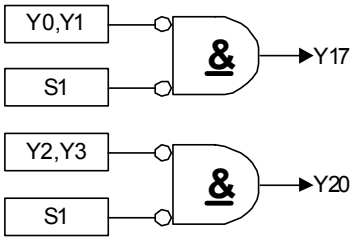



### ●Monitor output for safety output




Note1:
Monitor outputs for safety output 1 and 2 are turned OFF immediately independent of set OFF-delay time.

### ●Solenoid output (Note2)




Note2:
In Run state, when the safety outputs are OFF and 1 or more safety inputs are OFF, the solenoid outputs are turned ON.
When all safety inputs are ON, the solenoid outputs are turned OFF, although start input is OFF.

## Functions (Logic 1)

**●Safety inputs: X0 to X13 (T0 to T13)**

X0 to X13 (T0 to T13) function as dual channel direct opening inputs.
The combinations of dual channel inputs are as shown below. Incorrect use of these combinations will result in an error. The input monitor error detection time between dual channel inputs is 0.5s.
For information about connected control devices, see “SAFETY PRECAUTIONS” and following “Logic functions”.

X0-T0, X1-T1: Safety input 1
X2-T2, X3-T3: Safety input 2
X4-T4, X5-T5: Safety input 3
X6-T6, X7-T7: Safety input 4
X10-T10, X11-T11: Safety input 5
X12-T12, X13-T13: Safety input 6

**Warning**

Safety check signals (pulses signals) are sent from the drive terminals (T0 to T13) to diagnose connected safety devices and input circuits. Safety check signals can not be used as a power supply for connected devices.

Note: Solid state outputs, such as safety light curtains, can not be connected.

Note: If there are unused safety inputs, short the receive terminals (Xn) corresponding to the unused safety inputs and the drive terminals (Tn). If they are not shorted, the SG-ONE will not turn ON the safety outputs.

**●External device monitor inputs: X14 and X15 (T14 and T15)**

X14 and X15 (T14 and T15) function as external device monitoring inputs.
X14 and T14 are used as contact monitoring for external devices connected to Y0 and Y1.
X15 and T15 are used as contact monitoring for external devices connected to Y2 and Y3.

**Warning**

Safety check signals (pulses signals) are sent from the drive terminals (T14, T15) to diagnose external devices and monitor circuits. The safety check signal can not be used as a power supply for connected devices.

Note: If there are unused safety outputs, short the external device monitor terminals (Xn) corresponding to the unused safety outputs and the drive terminals (Tn). If they are not shorted, the SG-ONE detects an input monitor error. As the result, the error LED displays a “1” and the unit changes to the Protection state.

**●Start inputs: X16 and X17**

X16 is used to control the start of the safety outputs as “auto start” which does not use a start switch, or “manual start” which does not detect welding of the start switch. When the start input (X16) is turned ON (the ON state of X16 must be kept over 0.1s) during all devices connected to the safety inputs are in safe state, a start condition is established.

X17 is used to control the start of the safety outputs as “control start” which detects welding of the start switch. When the start input transits OFF→ON→OFF (the ON state of X17 must be kept during 0.1s to 5s) when all devices connected to the safety inputs are in safe state, the start condition is established.

Note: If both of X16 and X17 are turned ON, the SG-ONE will detect an error. As a result, the error LED displays “3” and the state changes to the Stop state. Use only X16 or X17.

**●Safety outputs (with OFF-delay timer): Y0 to Y3**

Y0 to Y3 function as safety outputs with the OFF-delay timer. When the timer is set to “0s” (indication “1”), the safety outputs are shut OFF immediately.

Y0 and Y1: Safety output 1
Y2 and Y3: Safety output 2

**●Safety input monitor outputs: Y4 to Y11**

Y4 toY11 function as status monitors of the safety input devices connected to the SG-ONE.
When both contacts of the safety device are ON, the output is ON. When both contacts are OFF, the output is OFF.
If an input monitor error is detected, pulses (1Hz) are sent.

Y4 outputs the status of the safety input 1 (X0-T0, X1-T1).
Y5 outputs the status of the safety input 2 (X2-T2, X3-T3).
Y6 outputs the status of the safety input 3 (X4-T4, X5-T5).
Y7 outputs the status of the safety input 4 (X6-T6, X7-T7).
Y10 outputs the status of the safety input 5 (X10-T10, X11-T11).
Y11 outputs the status of the safety input 6 (X12-T12, X13-T13)

**●Safety output monitor outputs: Y12 and Y13**

Y12 and Y13 function as monitor outputs that output the status of the safety outputs. When the safety outputs are OFF, the safety output monitor output is turned OFF immediately, even if the OFF-delay timer has been set.

Y12 outputs the status of safety output 1 (Y0 and Y1). This turns ON when Y0 and Y1 are both ON.

Y13 outputs the status of safety output 1 (Y2 and Y3). This turns ON when Y2 and Y3 are both ON.

**●State monitor outputs: Y14 to Y16**

Y14 to Y16 are monitor outputs for the internal status of the SG-ONE.

Y14 turns ON when in the Initial or Stop state.

Y15 turns ON in the Initial, Protection or Configuration state.

Y16 turns ON when in the Run state.

Refer to “Chapter 4 BASIC OPERATION”, or “Chapter 6 TROUBLESHOOTING”, for details of the each state.

The monitor outputs are not safety outputs. Do not use these to construct of a safety system.

**●Solenoid outputs: Y17 and Y20**

Y17 and Y20 are outputs for solenoid control that are used for a safety switch with a lock.

In the Run state, when the safety outputs are OFF and 1 or more safety inputs are OFF, the solenoid outputs are turned ON. When all safety inputs are ON, the solenoid outputs are turned OFF, although the start input is not activated.

Solenoid outputs are not safety outputs. Do not use these to construct of a safety system.

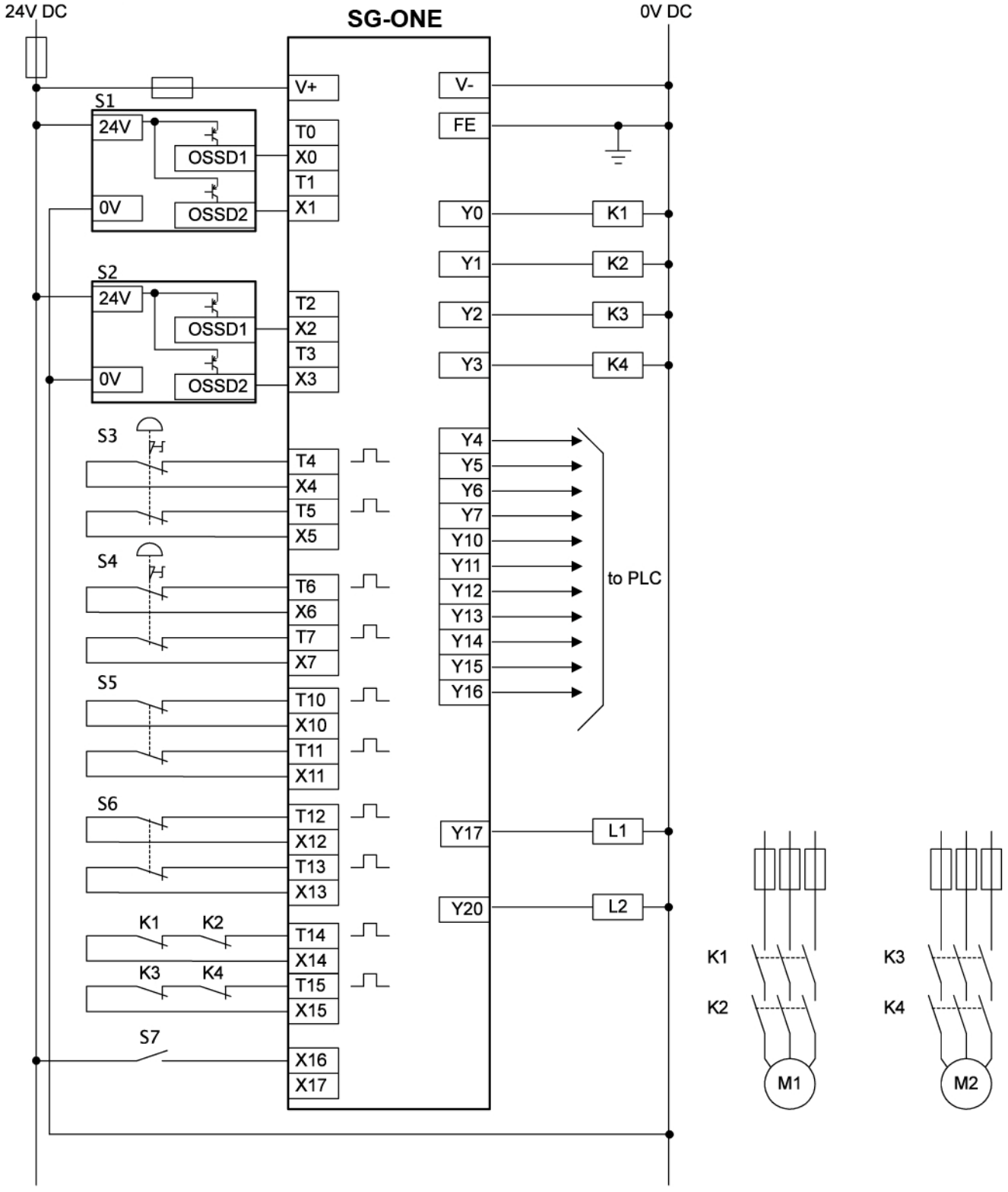
Refer to "Chapter 2 PRODUCT SPECIFICATIONS" for specifications of each input and output.

## Wiring example (Logic 1)

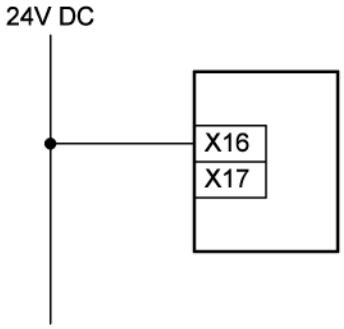
**In the case of 4 emergency stop switches and 2 safety switches with locks are connected.**

S1,2 :Safety light curtain
S3,4 :Emergency stop switch
S5,6 :Safety switch with lock (spring lock type)
S7 :Start switch
K1...4 :Contactor
L1,2 :Solenoid of safety switch for lock release
M1,2 :Motor

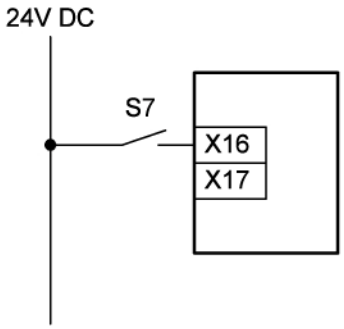
Fuse



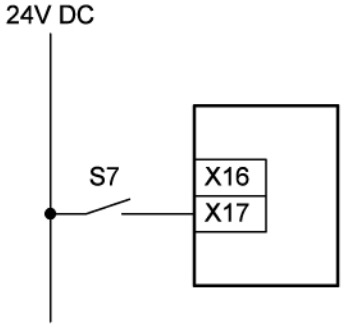
**When not using the start switch**
**DAuto startE**



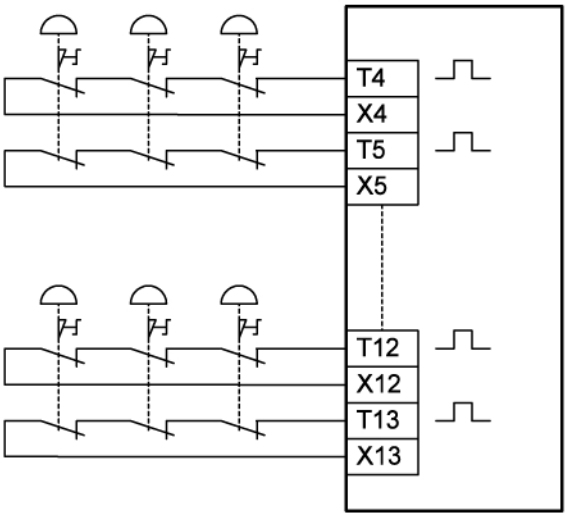

**When not detecting the welding of start switch**
**DManual startE**




**When detecting the welding of start switch**
**DControl startE**

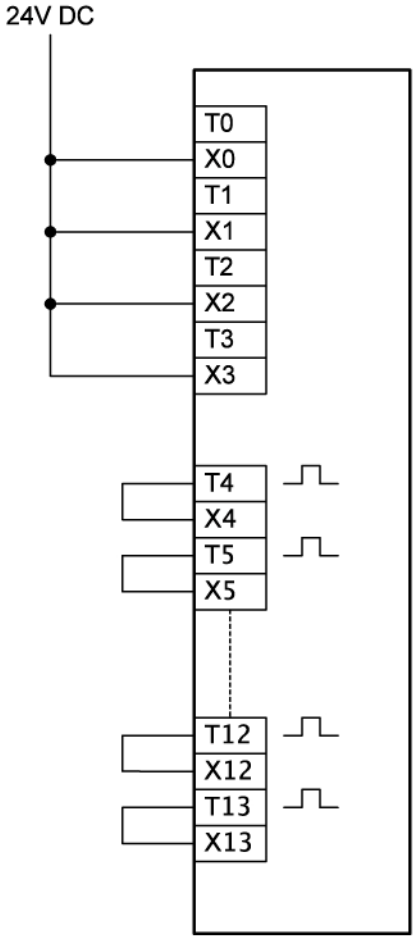



**When connecting multiple emergency stop switches in series**




NOTE:ѱApplicable safety performance is dependent upon each system configuration.

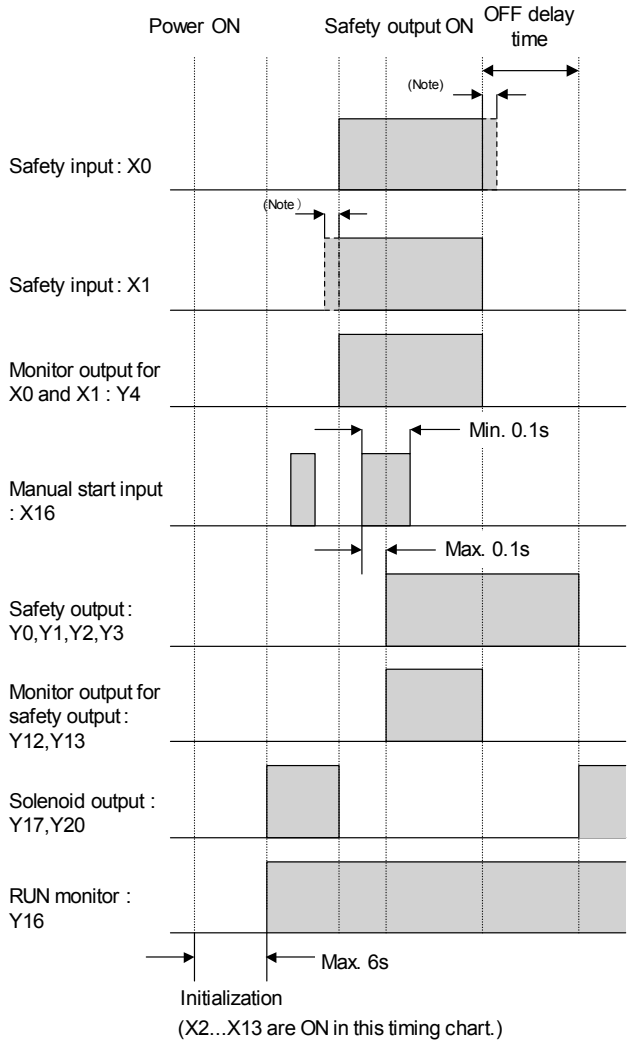
**When not using some safety inputs**



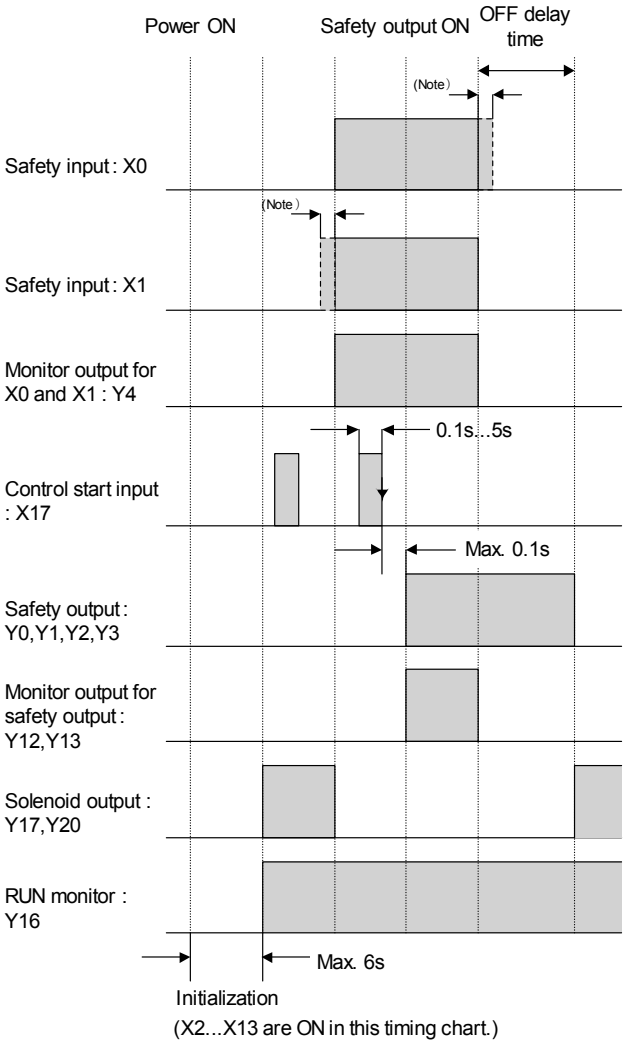

Note: In the case of using a spring lock type safety switch for the safety input of SG-ONE, if the solenoid output of SG-ONE is connected to solenoid power terminal of the safety switch directly, the start condition cannot be established due to the safety input stays in the OFF state. In this case, connect the switch or other equipment to solenoid output of SG-ONE, and turn off the operation of the solenoid for lock control.

## Timing chart (Logic 1)

**1.Case to use the manual start input (X16)**




**2.Case to use the control start input (X17)**



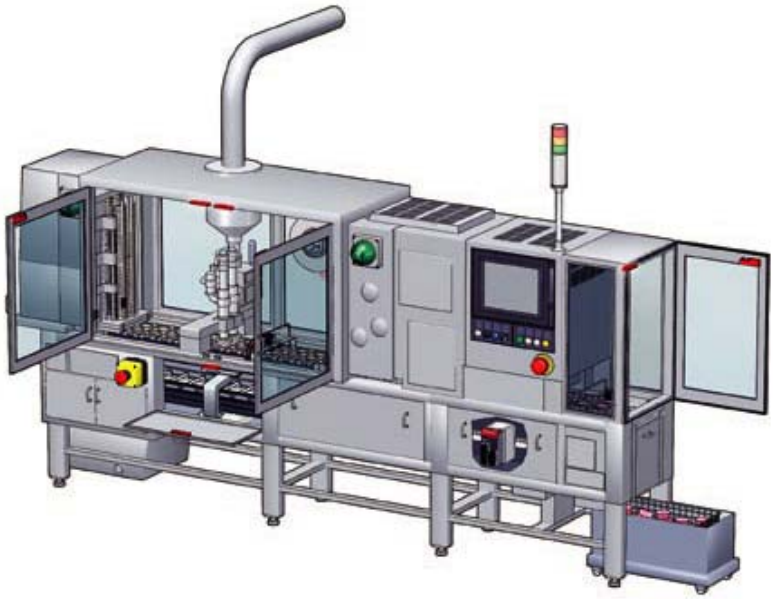

Note: When the input time difference at the dual channel safety inputs is 0.5s or more, the input monitor error is detected. Refer to the following "Logic functions" for details.

# Logic 2: General purpose logic for NO/NC contact inputs

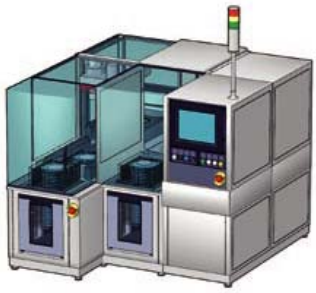
## Overview (Logic 2)

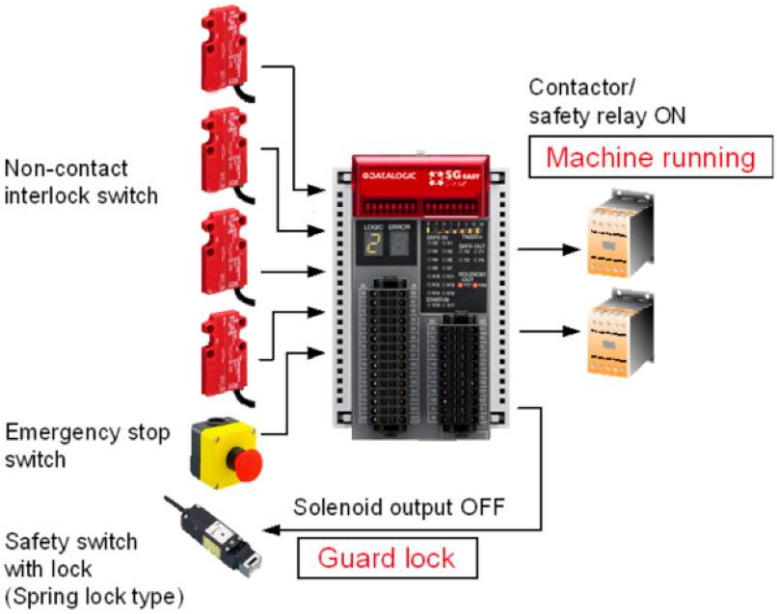
This logic function is for using dual channel NO/NC contact devices as safety protective measures for semiconductor manufacturing machines, food packaging machinery, and other machinery. This logic has 4 dual channel inputs for NO/NC contact devices and 2 dual inputs for direct opening inputs.

When all of the safety inputs are in the safe state (for NO/NC contact devices: NO contacts are ON and NC contacts are OFF (actuators are in installed in the interlock switches), for direct opening devices: all contacts are ON), safety outputs are turned ON with the start input. While the safety outputs are ON, if the safe state of any safety input devices is broken (for NO/NC contact device: NO contact is OFF or NC contact is ON (actuator is removed from interlock switch), for direct opening inputs: contact is OFF), the safety outputs are turned OFF after the preset OFF-delay time.

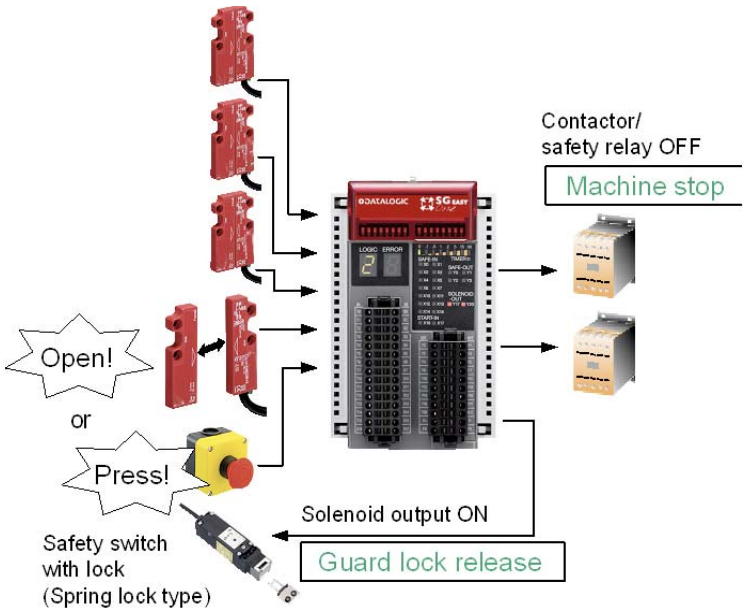


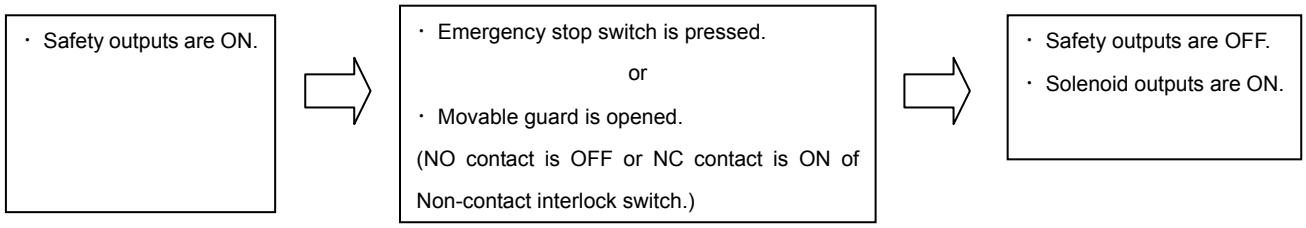
## Operation example (Logic 2)



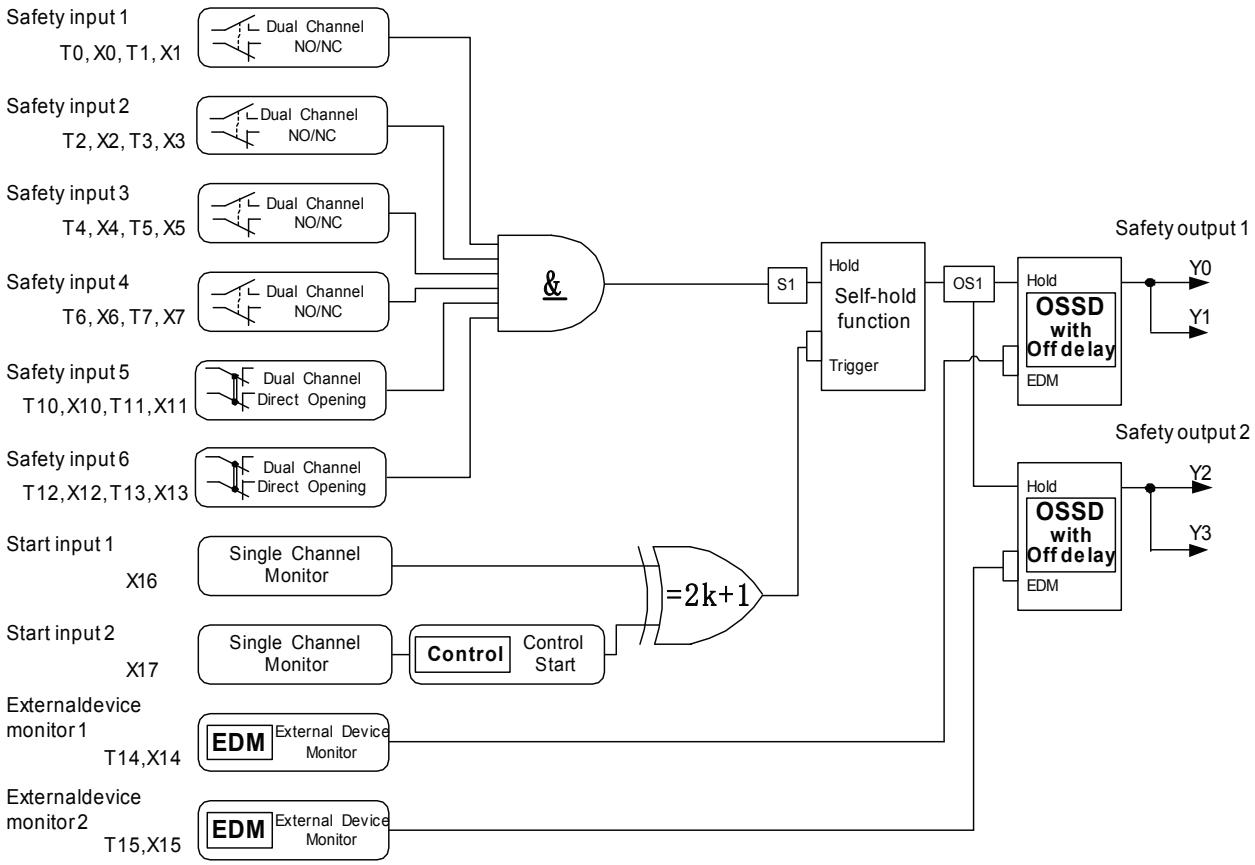



| | | |
|---|---|---|
| ・ Emergency stop switches in the rest position.<br>and<br>・ Movable guard is closed.<br>(All NO contacts are ON and NC contacts are OFF of Non-contact interlock switches.) | ・ Start input is ON | ・ Safety outputs are ON. |

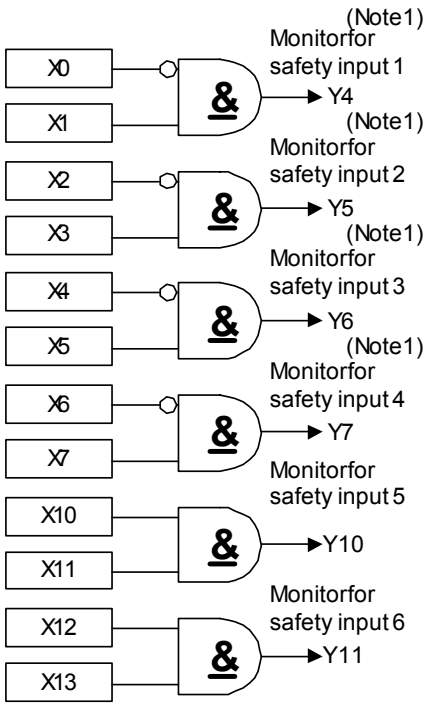



・ Safety outputs are ON.
・ Emergency stop switch is pressed.
or
・ Movable guard is opened.
(NO contact is OFF or NC contact is ON of Non-contact interlock switch.)
・ Safety outputs are OFF.
・ Solenoid outputs are ON.

## Logic circuit (logic 2)

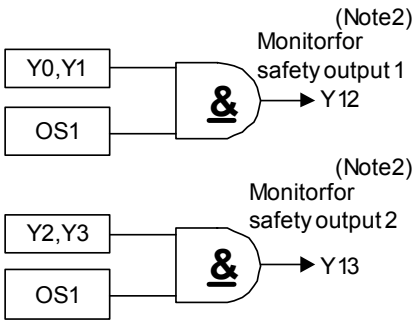



### ●Monitor output for safety input



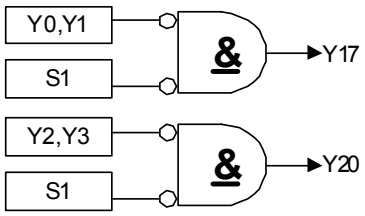

Note1:
When $X_n$ is OFF and $X_{n+1}$ is ON, the monitor output for safety input is turned on.
(n = 0,2,4,6)

### ●Monitor output for safety output




Note2:
Monitor outputs for safety output 1 and 2 are turned OFF immediately independent of the set OFF-delay time.

### ●Solenoid output (Note3)




Note3:
In Run state, when the safety outputs are OFF and 1 or more safety inputs are off, the solenoid outputs are turned ON.
When all safety inputs are ON, the solenoid outputs are turned OFF, Although start input is OFF.

## Functions (Logic 2)

● **Safety inputs: X0 toX13 (T0 to T13)**

X0 to X7 (T0 to T7) function as dual channel NO/NC inputs.

X10 to X13 (T10 to T13) function as dual channel direct opening inputs.

The combinations of the dual channel inputs are shown below. Incorrect use of these combinations will result in an error. The input monitor error detection time between dual channel inputs is 0.5s. For information about connected control devices, see “SAFETY PRECAUTIONS” following “Logic functions”.

X0-T0, X1-T1: Safety input 1

X2-T2, X3-T3: Safety input 2

X4-T4, X5-T5: Safety input 3

X6-T6, X7-T7: Safety input 4

X10-T10, X11-T11: Safety input 5

X12-T12, X13-T13: Safety input 6

**Warning**

Safety check signals (pulses signals) are transmitted from the drive terminals (T0 to T13) to diagnose connected safety devices and input circuits. Safety check signals can not be used as power for connected devices. In case of use of non-contact interlock switches with LEDs, refer to the “Wiring example (Logic 2)”.

Note: Solid state outputs, such as safety light curtains, can not be connected.

Note: If there are unused safety inputs, short or open between the receive terminals (Xn) corresponding to the unused safety inputs and the drive terminals (Tn) as shown below. If this is not done, then the SG-ONE will not turn ON the safety outputs.

Open： X0-T0, X2-T2, X4-T4, X6-T6

Short： X1-T1, X3-T3, X5-T5, X7-T7, X10-T10, X11-T11, X12-T12, X13-T13

● **External device monitor inputs： X14 and X15 (T14 and T15)**

X14 and X15 (T14 and T15) function as external device monitor inputs.

X14 and T14 are used as contact monitors for external devices connected to Y0 and Y1.

X15 and T15 are used as contact monitors for external devices connected to Y2 and Y3.

**Warning**

Safety check signals (pulses signals) are transmitted from the drive terminals (T14, T15) to diagnose external devices and monitor circuits. The safety check signal can not be used as the power for connected devices.

Note: If there are unused safety outputs, short between the external device monitor terminals (Xn) corresponding to the unused safety outputs and the drive terminals (Tn). If they are not shorted, the SG-ONE detects an input monitor error. As the result, the error LED displays “1” and the state changes to the Protection state.

**●Start inputs: X16 and X17**

X16 is used to control the start of the safety outputs as an “auto start” which does not use the start switch, or “manual start” which does not detect welding of the start switch. When the start input (X16) is turned ON (the ON state of X16 must be received for over 0.1s) during which all devices connected to the safety inputs are in safe state, the start condition is established.

X17 is used to control the start of the safety outputs as a “control start” which detects welding of the start switch. When the start input transmits OFF→ON→OFF (the ON state of X17 must be received for between 0.1s to 5s) during which all devices connected to the safety inputs are in the safe state, and then the start condition is established.

Note: If both of X16 and X17 are turned ON, the SG-ONE will detect an error. As the result, the error LED displays “3” and the state changes to the Stop state. Use either X16 or X17, but not both.

**●Safety outputs (with OFF-delay timer): Y0 to Y3**

Y0 to Y3 function as safety outputs with the OFF-delay timer. When the timer is set to “0s” (indication “1”), the safety outputs are shut OFF immediately.

Y0 and Y1: Safety output 1
Y2 and Y3: Safety output 2

**● Safety input monitor outputs: Y4 to Y11**

Y4 to Y11 function as status monitors of the safety input devices connected to the SG-ONE.

Y4 to Y7: When safety devices are connected to X0 to X7 (T0 to T7), the output is ON while the contacts connected to X0, X2, X4, and X6 are OFF and while the contacts connected to X1, X3, X5, and X7 are ON.

Y10 and Y11: When the both contacts of the safety device connected to safety output 5 and 6 are ON, the output is ON. When both contacts are OFF, the output is OFF.

If an input monitor error is detected, pulses of (1Hz) are transmitted.

Y4 outputs the status of safety input 1 (X0-T0, X1-T1).
Y5 outputs the status of safety input 2 (X2-T2, X3-T3).
Y6 outputs the status of safety input 3 (X4-T4, X5-T5).
Y7 outputs the status of safety input 4 (X6-T6, X7-T7).
Y10 outputs the status of safety input 5 (X10-T10, X11-T11).
Y11 outputs the status of safety input 6 (X12-T12, X13-T13).

**●Safety output monitor outputs: Y12 and Y13**

Y12 and Y13 function as monitoring outputs that output the status of the safety outputs. When the safety outputs are OFF, the safety output monitor output is turned OFF immediately, even if the OFF-delay timer has been set.

Y12 outputs the status of safety output 1 (Y0 and Y1). This turns ON when Y0 and Y1 are both ON.

Y13 outputs the status of safety output 1 (Y2 and Y3). This turns ON when Y2 and Y3 are both ON.

**●State monitor outputs: Y14 to Y16**

Y14 to Y16 monitor outputs for the internal status of the SG-ONE.

Y14 turns ON during Initial state or Stop state.

Y15 turns ON in the Initial state, Protection state or Configuration state.

Y16 turns ON while in the Run state.

Refer to “Chapter 4 BASIC OPERATION”, or “Chapter 6 TROUBLESHOOTING”, for details of each state.

**Warning**

Monitor outputs are not safety outputs. Do not use these to construct a safety system.

**●Solenoid outputs: Y17 and Y20**

Y17 and Y20 are outputs for solenoid control that are used for a safety switch with a lock.

In the Run state, when the safety outputs are OFF and 1 or more safety inputs are OFF, the solenoid outputs are ON. When all safety inputs are ON, the solenoid outputs are OFF, although the start input is not activated.

**Warning**

Solenoid outputs are not safety outputs. Do not use these to construct a safety system.

**Caution**

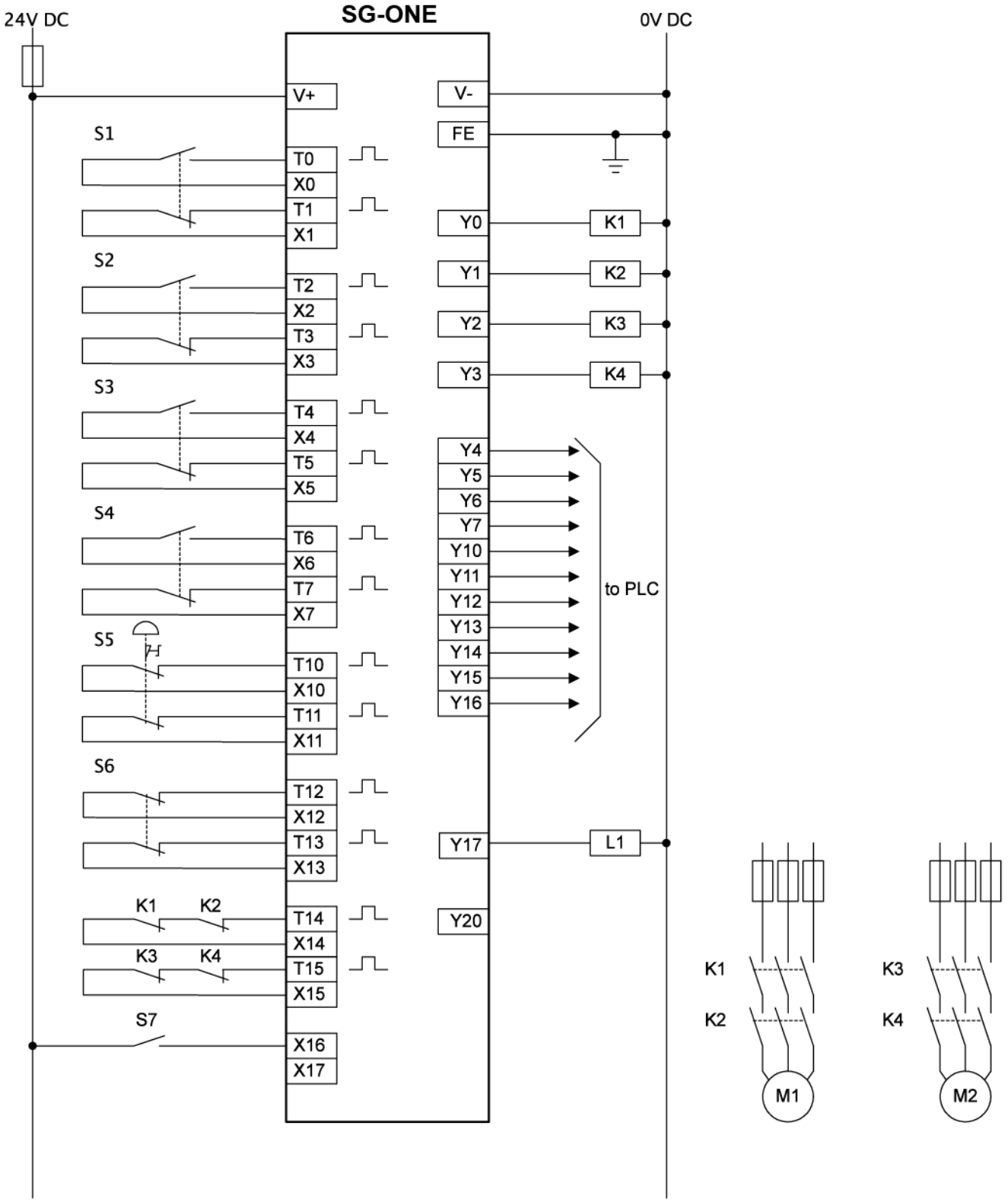
Refer to "Chapter 2 PRODUCT SPECIFICATIONS" for specifications of each input and output.

## Wiring example (Logic 2)

**Incase of 4 non-contact interlock switches, 1 emergency stop switch, and 1 safety switch with lock are connected.**

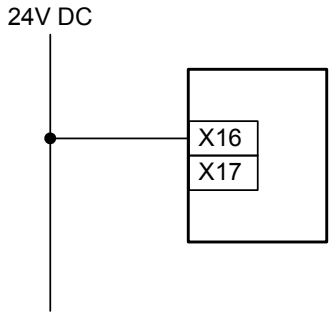
S1...4 :Non-contact interlock switch
S5 :Emergency stop switch
S6 :Safety switch with lock (spring lock type)
S7 :Start switch
K1...4 :Contactor
L1 :Solenoid of safety switch for lock release
M1,2 :Motor

Fuse



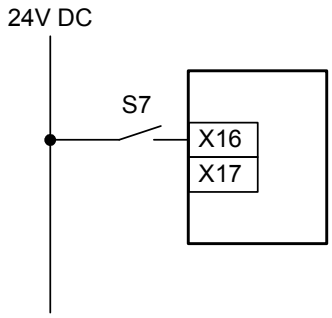
**When not using the start switch**

**Auto start**



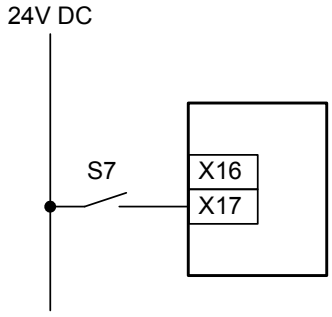

**When not detecting the welding of start switch**

**Manual Start**

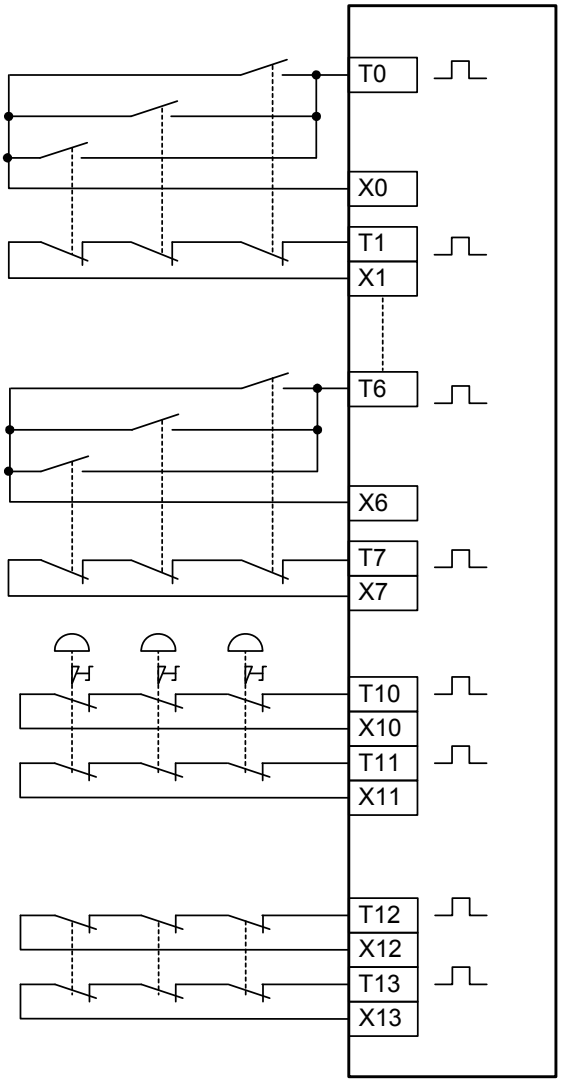



**When detecting the welding of start switch**

**Control start**

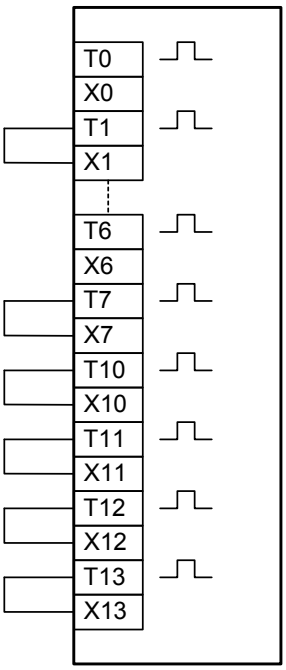



**When connecting multiple components in series**




NOTE: Applicable safety performance is dependent on each system configuration.

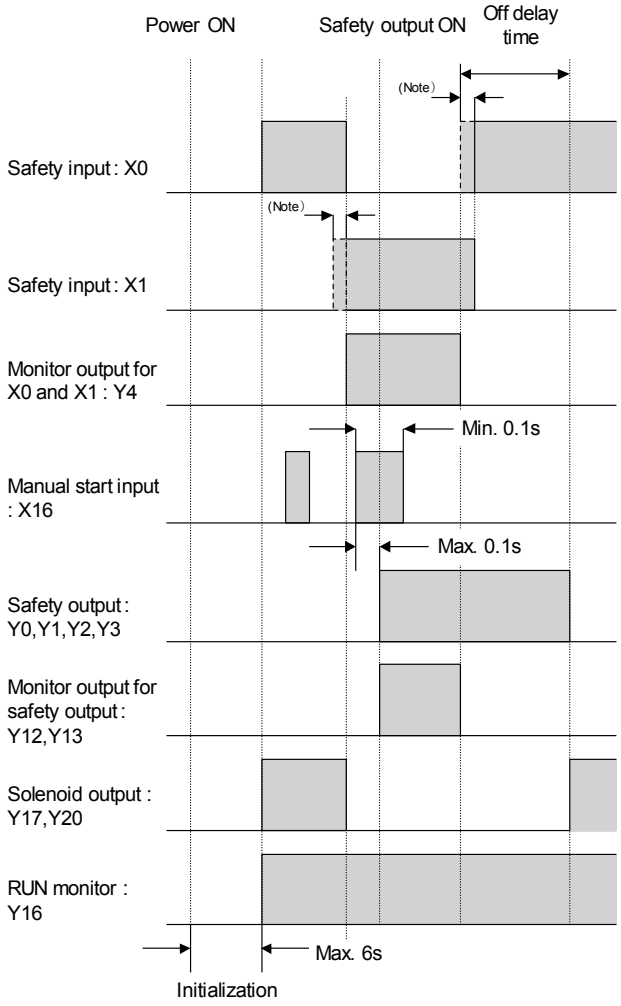
**When not using some safety inputs**




Note: In the case of using a spring lock safety switch for the safety input of SG-ONE, if solenoid output of SG-ONE is connected to solenoid power terminal of the safety switch directly, the start condition cannot be established due to the safety input stays in the OFF state. In this case, connect the switch or other equipment to the solenoid output of SG-ONE, and use the OFF operation of the solenoid for lock control.

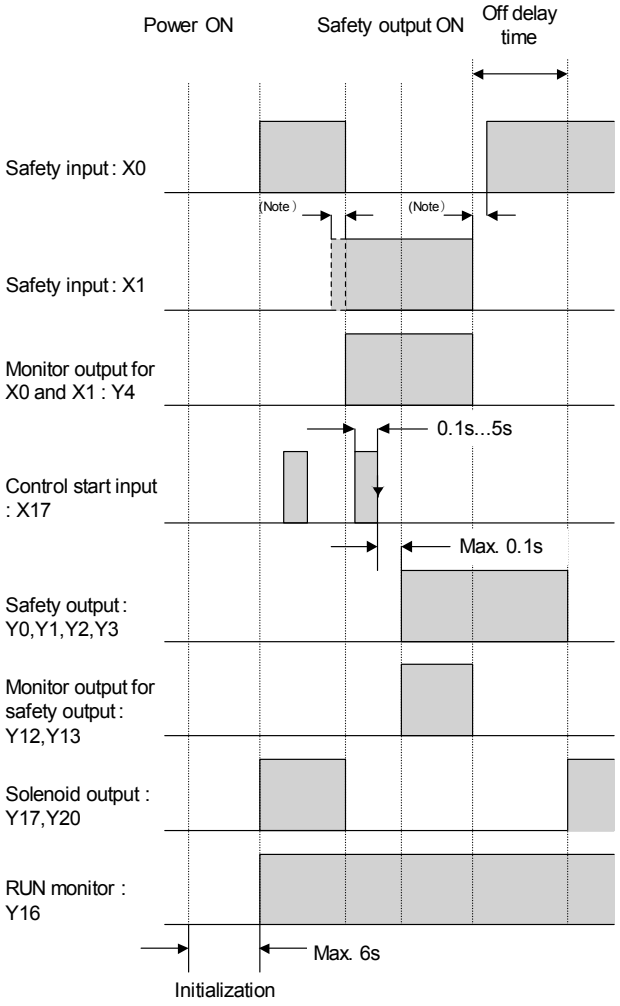
## Timing chart (Logic 2)

1.Case to use the manual start input (X16)




(X2, X4 and X6 are OFF and X3, X5, X7 and X10...X13 are ON in this timing chart.)

2.Case to use the control start input (X17)




(X2, X4 and X6 are OFF and X3, X5, X7 and X10...X13 are ON in this timing chart.)

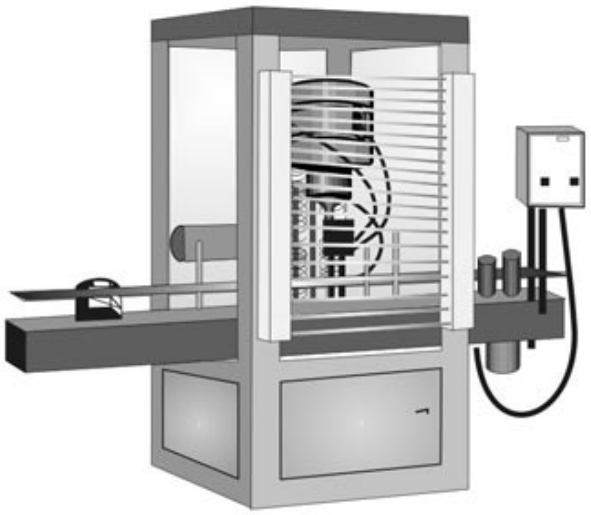
Note: When the input time difference for the dual channel safety inputs is 0.5s or more, an input monitor error is detected. Refer to the following "Logic functions" for details.

# Logic 3: General purpose logic for machines with openings

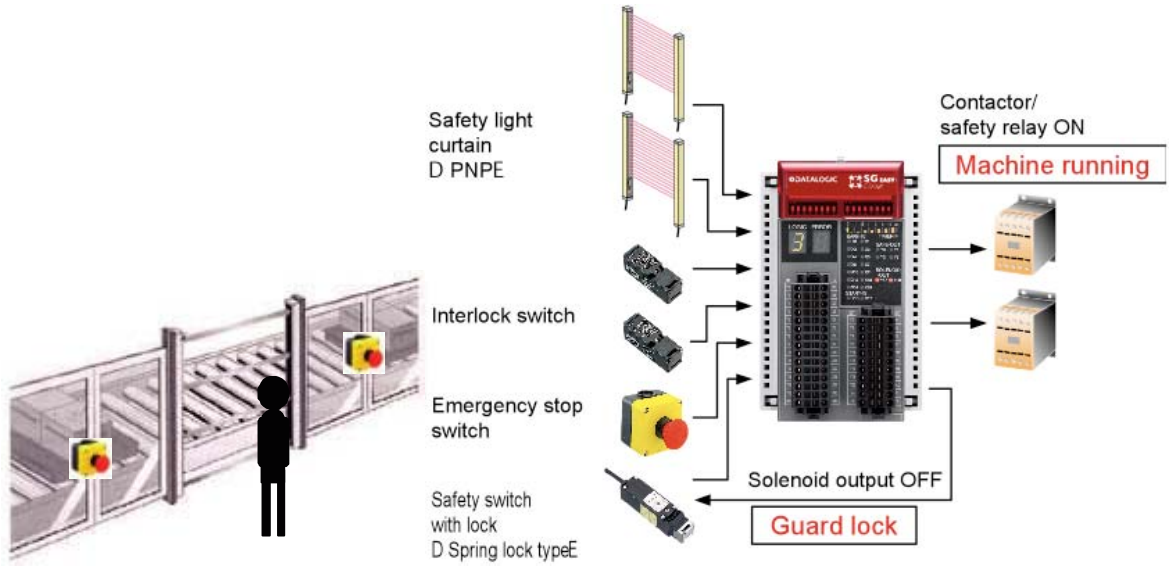
## Overview (Logic 3)

This logic is for using safety devices with dual channel solid state outputs, such as safety light curtains, for safety protective measures of production machinery, robots, and other machinery. This logic enables the connection of 2 dual channel solid state output (PNP) devices and 4 dual channel direct opening inputs.

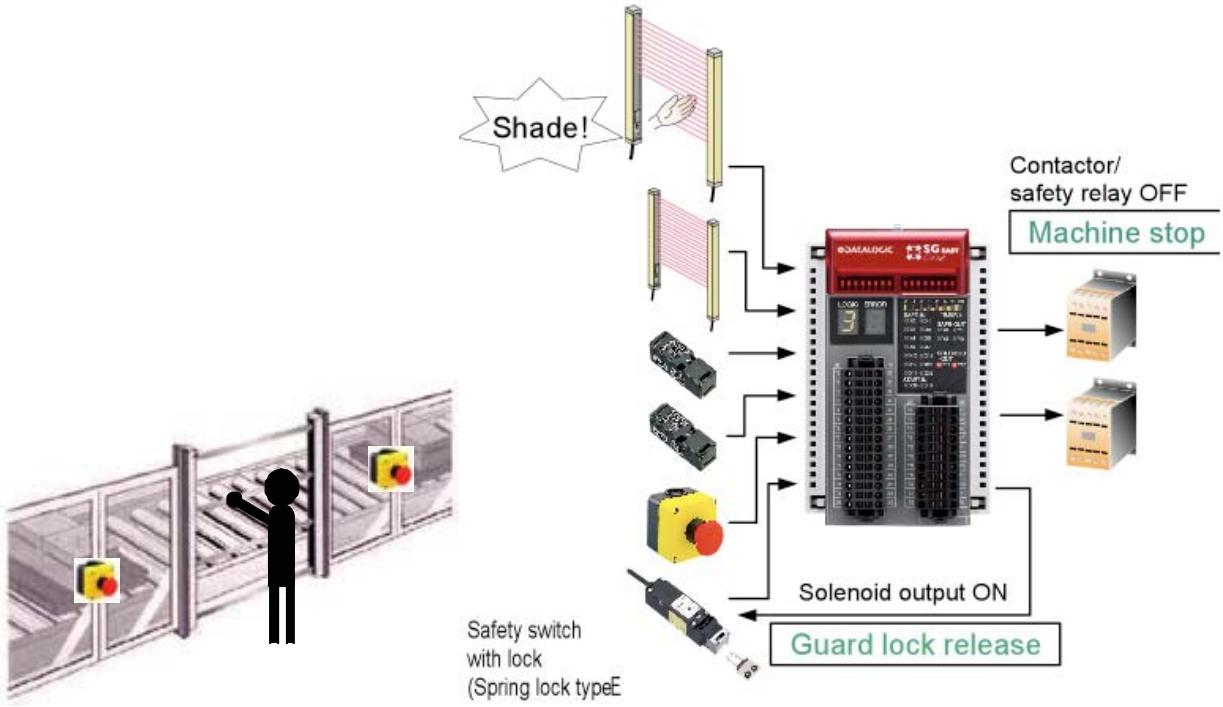
When in this state all of the safety inputs are receiving safety input signals (24V DC is applied from the solid state output devices, and the all contacts of contact devices are closed), the safety outputs are turned ON upon input of the start input. If any of the safety input signals is cut OFF while the safety outputs are ON, the safety outputs are turned OFF after the preset OFF-delay time.



## Operation example (Logic 3)

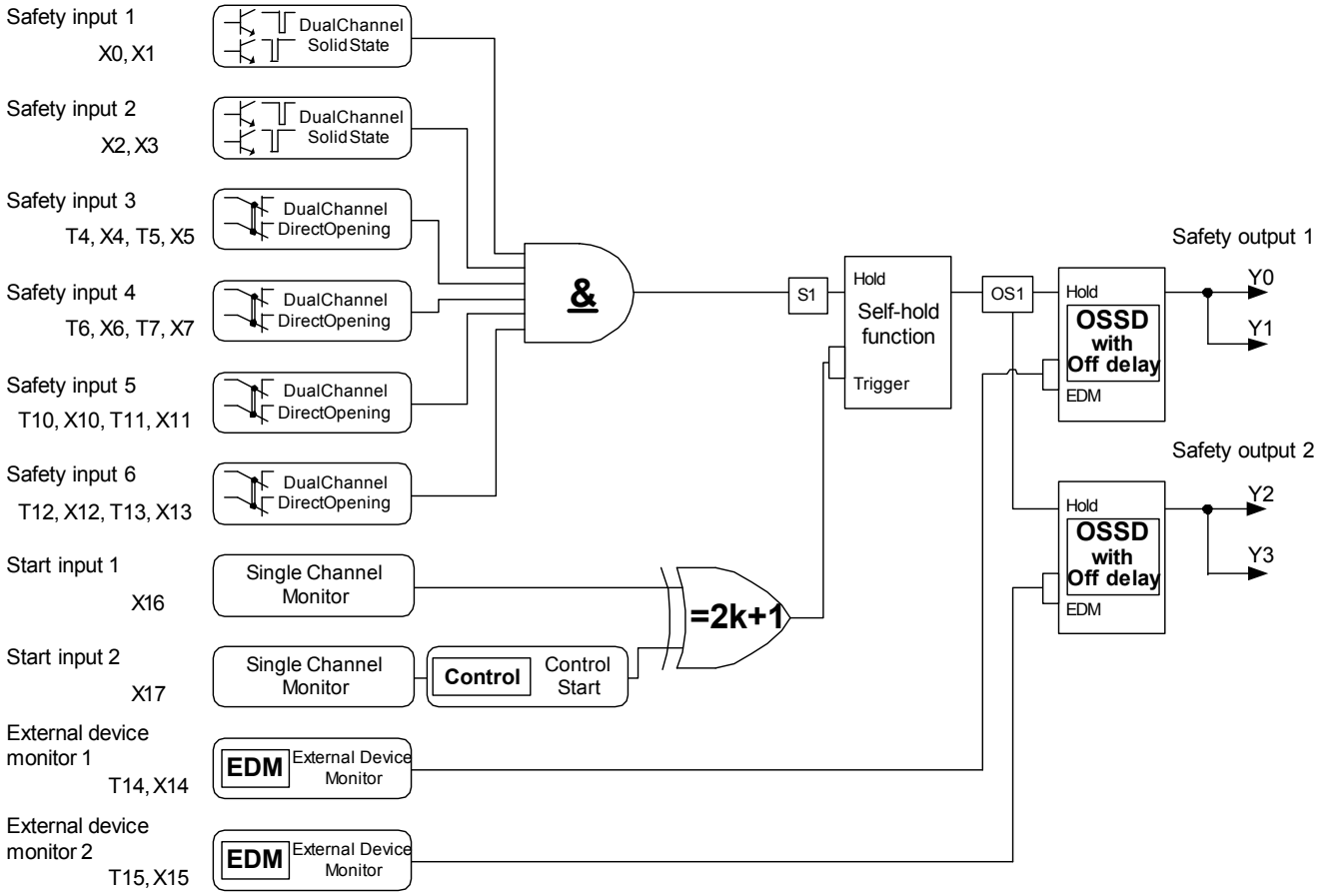



| | | |
|---|---|---|
| ・ Emergency stop switch is released.<br>and<br>・ Invasions through the opening are not detected. | ⇨ | ・ Start input is ON | ⇨ | ・ Safety outputs are ON. |

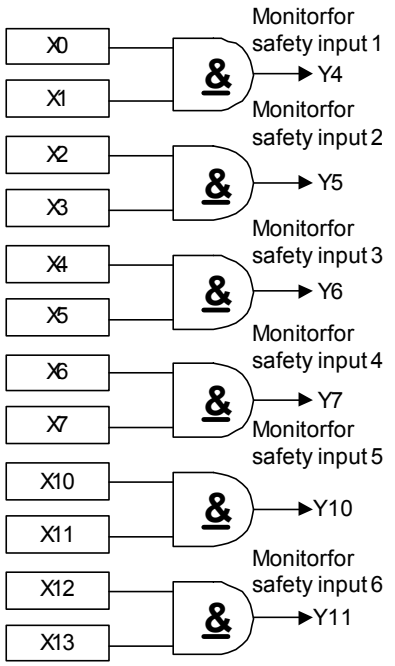



| | | |
|---|---|---|
| ・ Safety outputs are ON. | ⇨ | ・ Emergency stop switch is pressed.<br>or<br>・ Invasion through opening is detected. | ⇨ | ・ Safety outputs are OFF.<br>・ Solenoid outputs are ON. |

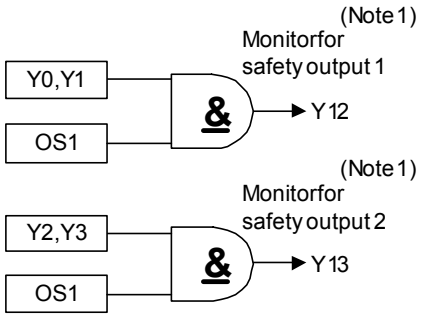
## Logic circuit (Logic 3)




### ●Monitor output for safety input

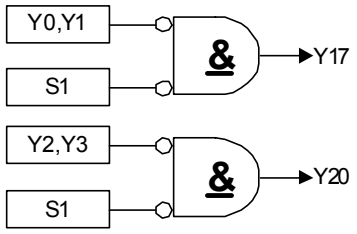



### ●Monitor output for safety output




Note 1:
Monitor outputs for safety output 1 and 2 are turned OFF immediately independent of set OFF-delay time.

### ●Solenoid output (Note 2)




Note 2:
In Run state, when the safety outputs are OFF and 1 or more safety inputs are OFF, the solenoid outputs are turned ON.
When all safety inputs are ON, the solenoid outputs are turned OFF, although start input is OFF.

## Functions (Logic 3)

**●Safety inputs: X0 to X13 (T4 to T13)**

X0 to X3 function as dual channel solid state inputs. These enable the connection of dual channel solid state output (PNP) devices.

X4 to X13 (T4 to T13) function as dual channel direct opening inputs.

The combinations of dual channel inputs are as shown below. Incorrect use of these combinations will result in error. The input monitor error detection time for dual channel solid state inputs is 0.1 s. The input monitor error detection time for dual channel direct opening inputs is 0.5 s.

For information about connected control devices, see “SAFETY PRECAUTIONS” following “Logic functions”.

X0, X1: Safety input 1

X2, X3: Safety input 2

X4-T4, X5-T5: Safety input 3

X6-T6, X7-T7: Safety input 4

X10-T10, X11-T11: Safety input 5

X12-T12, X13-T13: Safety input 6

Safety check signals (pulses signals) are transmitted from the drive terminals (T4 to T13) to diagnose connected safety devices and input circuits. Safety check signals can not be used as power for connected devices.

Note: Don’t use T0 to T3.

Note: If there are unused safety inputs, for safety input 1 or safety input 2 (receive terminals: X0 to X3), apply 24V DC to the terminals not connected to safety devices.

For safety input 3 to 6 (receive terminals: X4 to X13, drive terminals: T4 to T13), short between the receive terminal (Xn) and the drive terminal (Tn).

If this is not done, then the SG-ONE will not turn ON the safety outputs.

**●External device monitor inputs: X14 and X15 (T14 and T15)**

X14 and X15 (T14 and T15) function as external device monitoring inputs.

X14 and T14 are used as contact monitors for external devices connected to Y0 and Y1.

X15 and T15 are used as contact monitors for external devices connected to Y2 and Y3.

Safety check signals (pulses signals) are transmitted from the drive terminals (T14,T15) to diagnose external devices and monitoring circuits. The safety check signal can not be used as power for connected devices.

Note: If there are unused safety outputs, short between the external device monitor terminals (Xn) corresponding to the unused safety outputs and the drive terminals (Tn). If they are not shorted, the SG-ONE detects an input monitor error. As the result, the error LED displays “1” and the state changes to the Protection state.

**●Start inputs: X16 and X17**

X16 is used to control the start of safety outputs as an “auto start” which does not use a start switch, or “manual start” which does not detect welding of a start switch. When a start input (X16) is turned ON (the ON state of X16 must be kept over 0.1s) while all devices connected to the safety inputs are in the safe state, the start condition is established.

X17 is used to control the start of the safety outputs as a “control start” which detects welding of the start switch. When the start input changes from OFF→ON→OFF (the ON state of X17 must be maintained between to 0.1s to 5s) while all devices are connected to the safety inputs in safe state, the start condition is established.

Note: If both of X16 and X17 are turned ON, the SG-ONE will detect an error. As the result, the error LED displays “3” and the state changes to the Stop state. Use either X16 or X17.

**●Safety outputs (with OFF-delay timer): Y0 to Y3**

Y0 to Y3 function as safety outputs with the OFF-delay timer. When the timer is set to “0s” (indication “1”), the safety outputs are shut OFF immediately.

Y0 and Y1: Safety output 1
Y2 and Y3: Safety output 2

**●Safety input monitor outputs: Y4 to Y11**

Y4 to Y11 function as status monitors of safety input devices connected to the SG-ONE.

Y4 and Y5: When 24V DC is applied to both terminals of “X0 and X1” or “X2 and X3”, Y4 or Y5 is turned ON.

Y6 to Y11: When both contacts of the safety device, connected to safety output 3 to 6, are ON, the output is ON. When the both contacts are OFF, the output is OFF.

If an input monitor error is detected, pulses (1Hz) are transmitted.

Y4 outputs the status of safety input 1 (X0 and X1).
Y5 outputs the status of safety input 2 (X2 and X3).
Y6 outputs the status of safety input 3 (X4-T4, X5-T5).
Y7 outputs the status of safety input 4 (X6-T6, X7-T7).
Y10 outputs the status of safety input 5 (X10-T10, X11-T11).
Y11 outputs the status of safety input 6 (X12-T12, X13-T13).

**●Safety output monitor outputs: Y12 and Y13**

Y12 and Y13 function as monitoring outputs that output the status of safety outputs. When the safety outputs are OFF, the safety output monitor output is turned OFF immediately, even if OFF-delay timer has been set.

Y12 outputs the status of safety output 1 (Y0 and Y1). This turns ON when Y0 and Y1 are both ON.

Y13 outputs the status of safety output 2 (Y2 and Y3). This turns ON when Y2 and Y3 are both ON.

**●State monitor outputs: Y14 to Y16**

Y14 to Y16 are monitoring outputs for the internal status of the SG-ONE.

Y14 turns ON when in Initial or Stop state.

Y15 turns ON in Initial, Protection or Configuration state.

Y16 turns ON in Run state.

Refer to “Chapter 4 BASIC OPERATION”, or “Chapter 6 TROUBLESHOOTING”, for details of the each state.

Monitor outputs are not safety outputs. Do not use these to construct a safety system.

**●Solenoid outputs: Y17 and Y20**

Y17 and Y20 are outputs for solenoid control that are used for safety interlock switch with a solenoid lock.

In the Run state, when the safety outputs are OFF and 1 or more safety inputs are OFF, the solenoid outputs are turned ON. When all safety inputs are ON, the solenoid outputs are turned OFF, although start input is not activated.

Solenoid outputs are not safety outputs. Do not use these to construct a safety system.

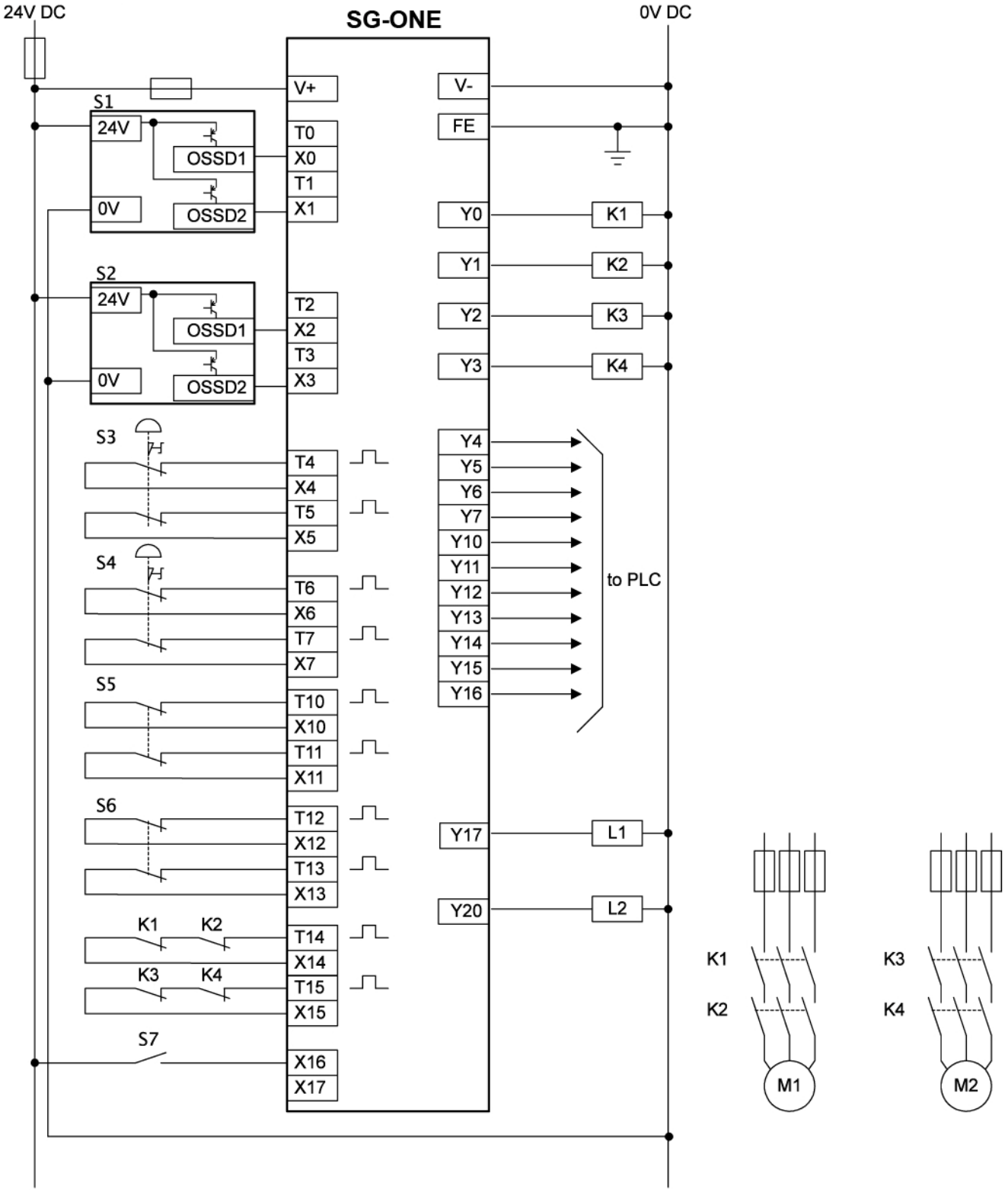
Refer to "Chapter 2 PRODUCT SPECIFICATIONS" for specifications of each input and output.

## Wiring example (Logic 3)

**2 safety light curtains, 2 emergency stop switches, and 2 safety switches with solenoid lock are connected.**

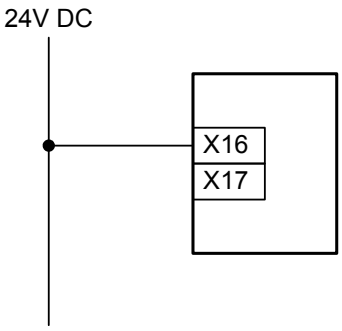
S1,2 :Safety light curtain
S3,4 :Emergency stop switch
S5,6 :Safety switch with lock (spring lock type)
S7 :Start switch
K1...4 :Contactor
L1,2 :Solenoid of safety switch for lock release
M1,2 :Motor

Fuse



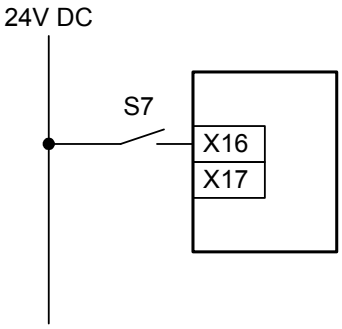
**When not using the start switch**

**Auto start**



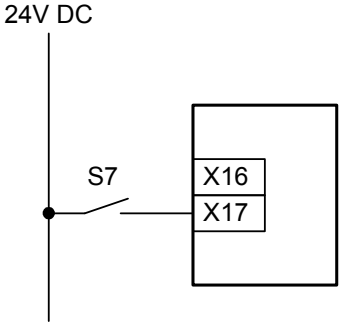

**When not detecting the welding of start**

**Manual Start**

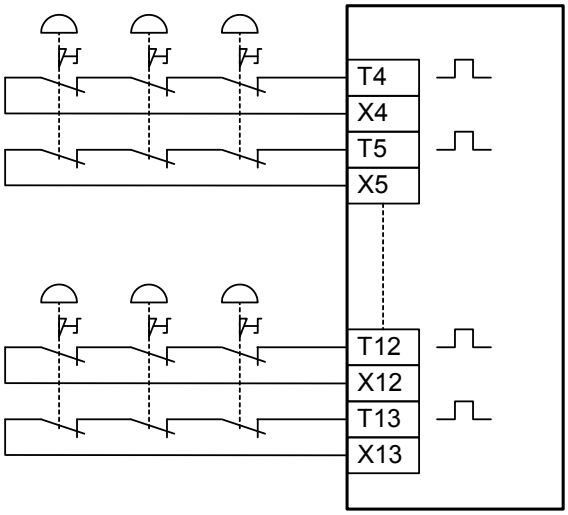



**When detecting the welding of start**

**Control start**

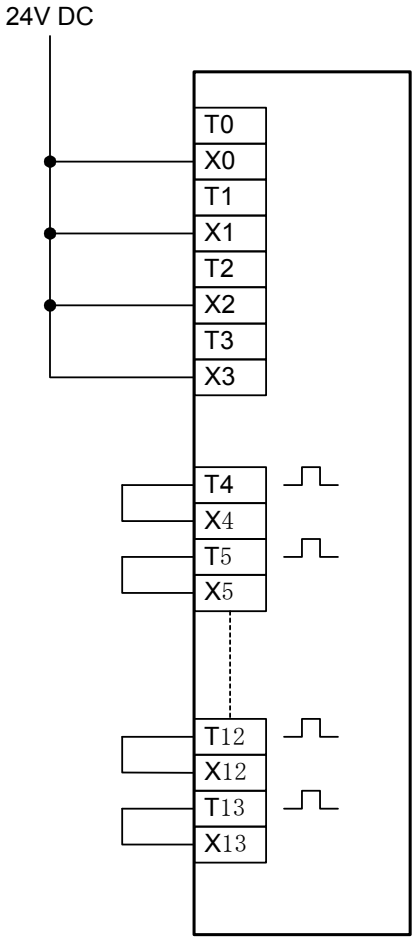



**When connecting multiple emergency stop switches in series**




NOTE: Applicable safety performance is dependent upon each system configuration.

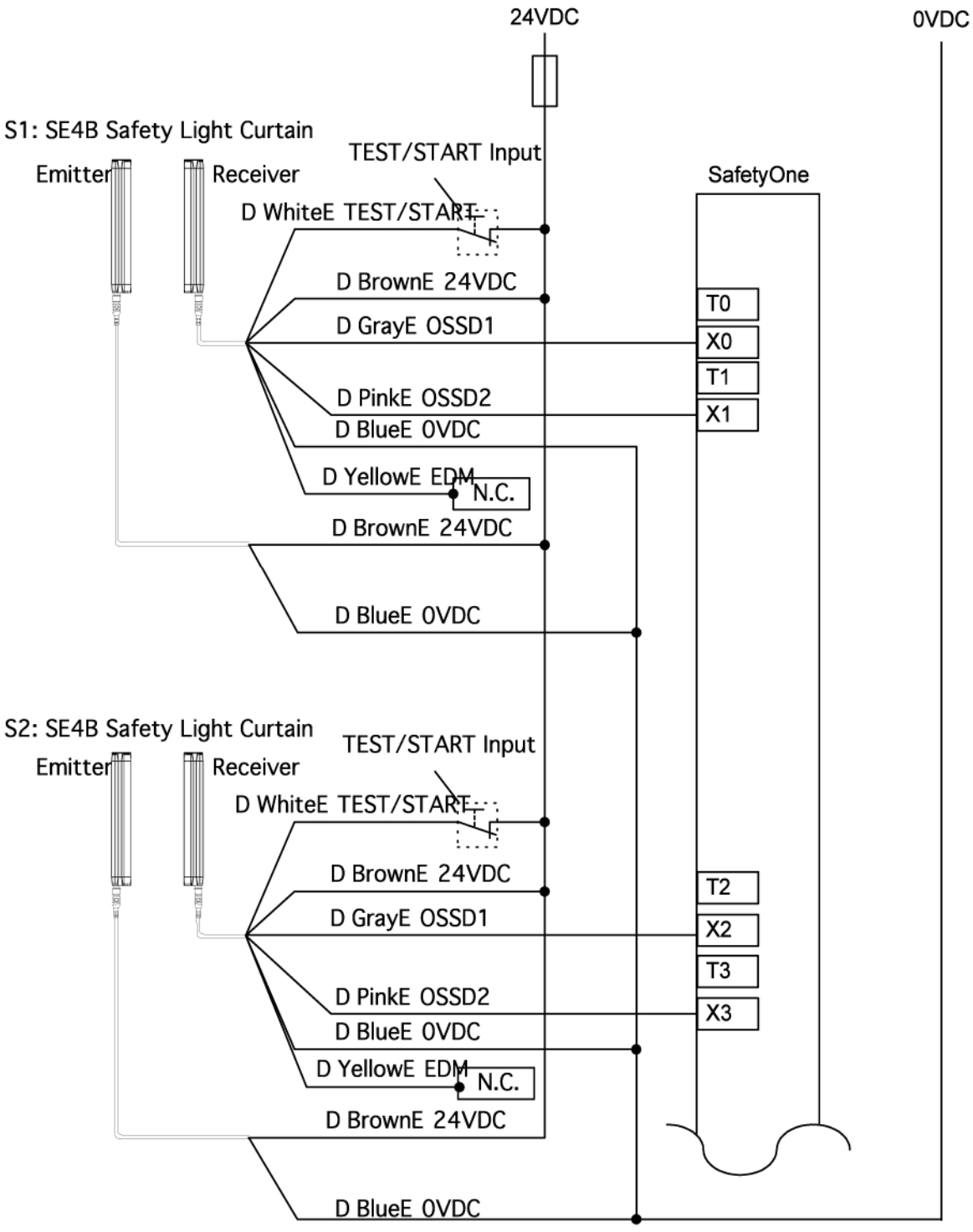
**When not using some safety inputs**




Note: When using a spring lock type safety switch for a safety input of the SG-ONE, if the solenoid output of SG-ONE is connected to the solenoid power terminal of the safety switch directly, then the start condition cannot be established due to the safety input staying in the OFF state. In this case, connect the switch or other equipment to the solenoid output of SG-ONE, and use the OFF operation of the solenoid for lock control.

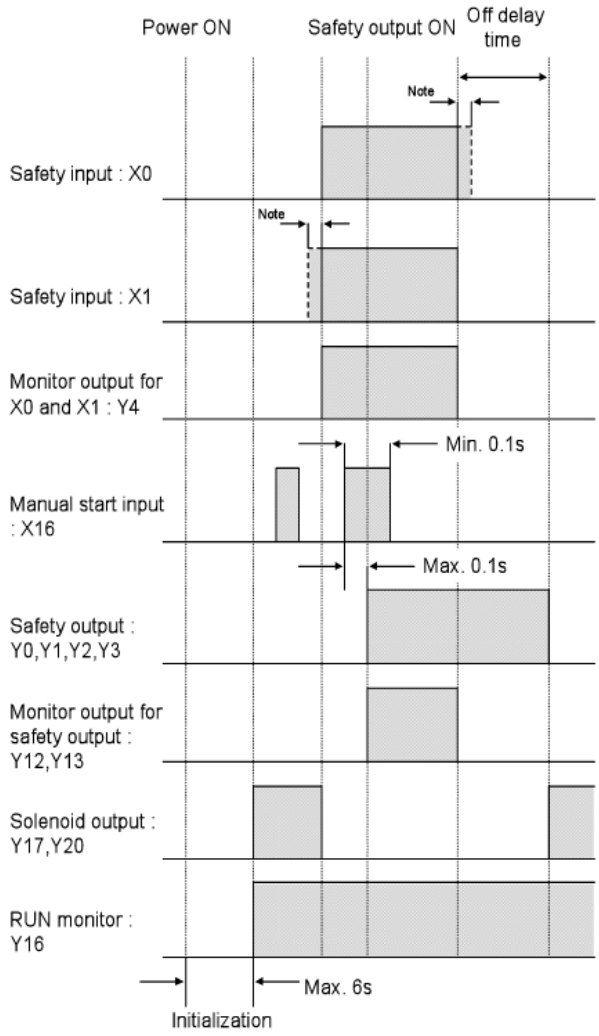
Using an DATALOGIC AUTOMATION light curtain SE series as S1, S2

S1! 2 $ SE Safety Light Curtain



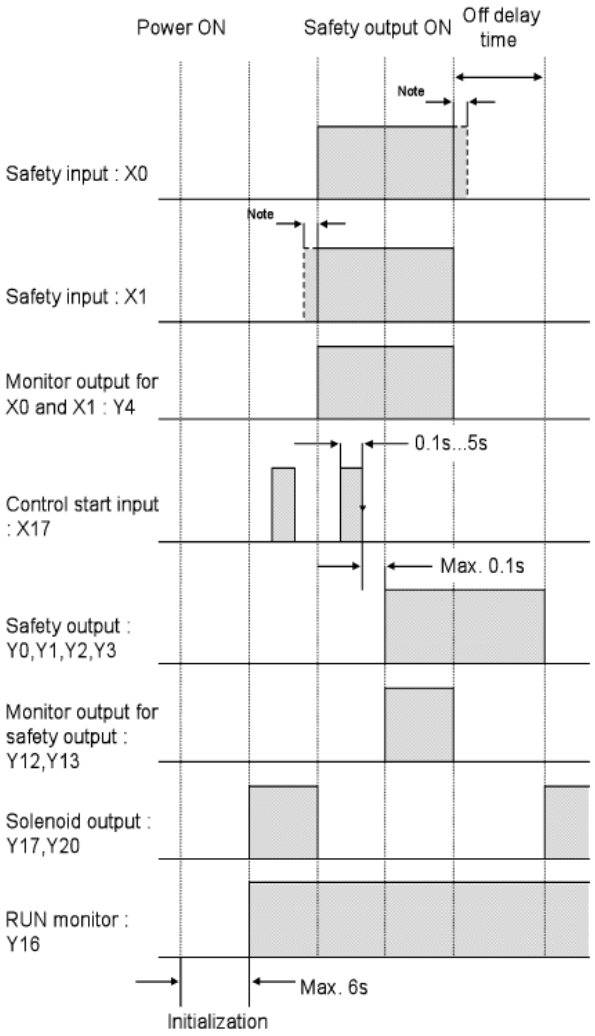
## Timing chart (Logic 3)

1.Using the manual start input (X16)




(X2...X13 are ON in this timing chart.)

2.Using the control start input (X17)




(X2...X13 are ON in this timing chart.)

Note: When the input time difference at the dual channel solid state inputs (X0-X1 and X2-X3) is 0.1s or more, an input monitor error is detected .
When the input time difference at the dual channel direct opening inputs (X4-X5, X6-X7, X10-X11, and X12-X13) is 0.5s or more, an input monitor error is detected.
Refer to "Logic functions" for details.

## Logic 4: Muting function logic for machines with openings

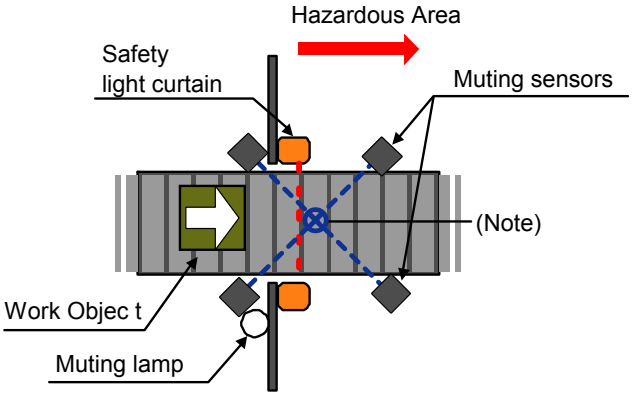
# Overview (Logic 4)

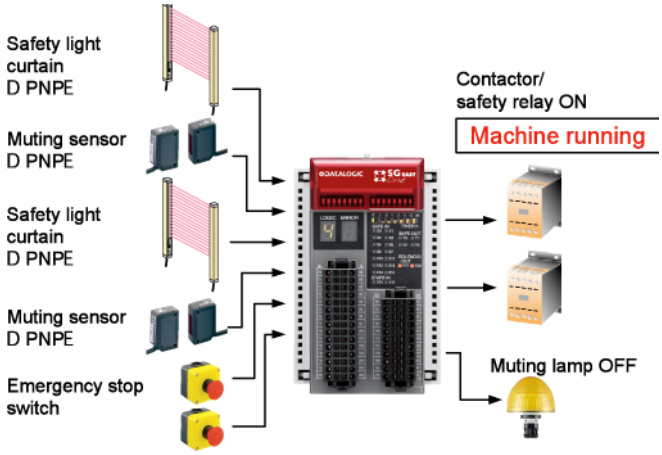
The logic described is for using safety devices with dual channel solid state outputs, such as safety light curtains (Ex. SG2, SG4, SG BODY and SE series), and for devices with output muting signals that enable muting functions that temporarily suspend safety functions of safety devices for safety protective measures of robots, conveyor lines, and other machines. This logic enables the connection of 2 dual channel solid state output (PNP) devices, 2 muting signal output (PNP) devices (Ex. S3Z, S8, S60, S300 Muting sensor series, limit switch), and 2 dual channel direct opening inputs.

When all of the safety inputs (X0, X1, X4, X5, and X10 to X13) are receiving safety input signals (24V DC is applied from the solid state output devices, and the all contacts of connected devices are closed), the safety outputs are turned ON upon input of the start input.

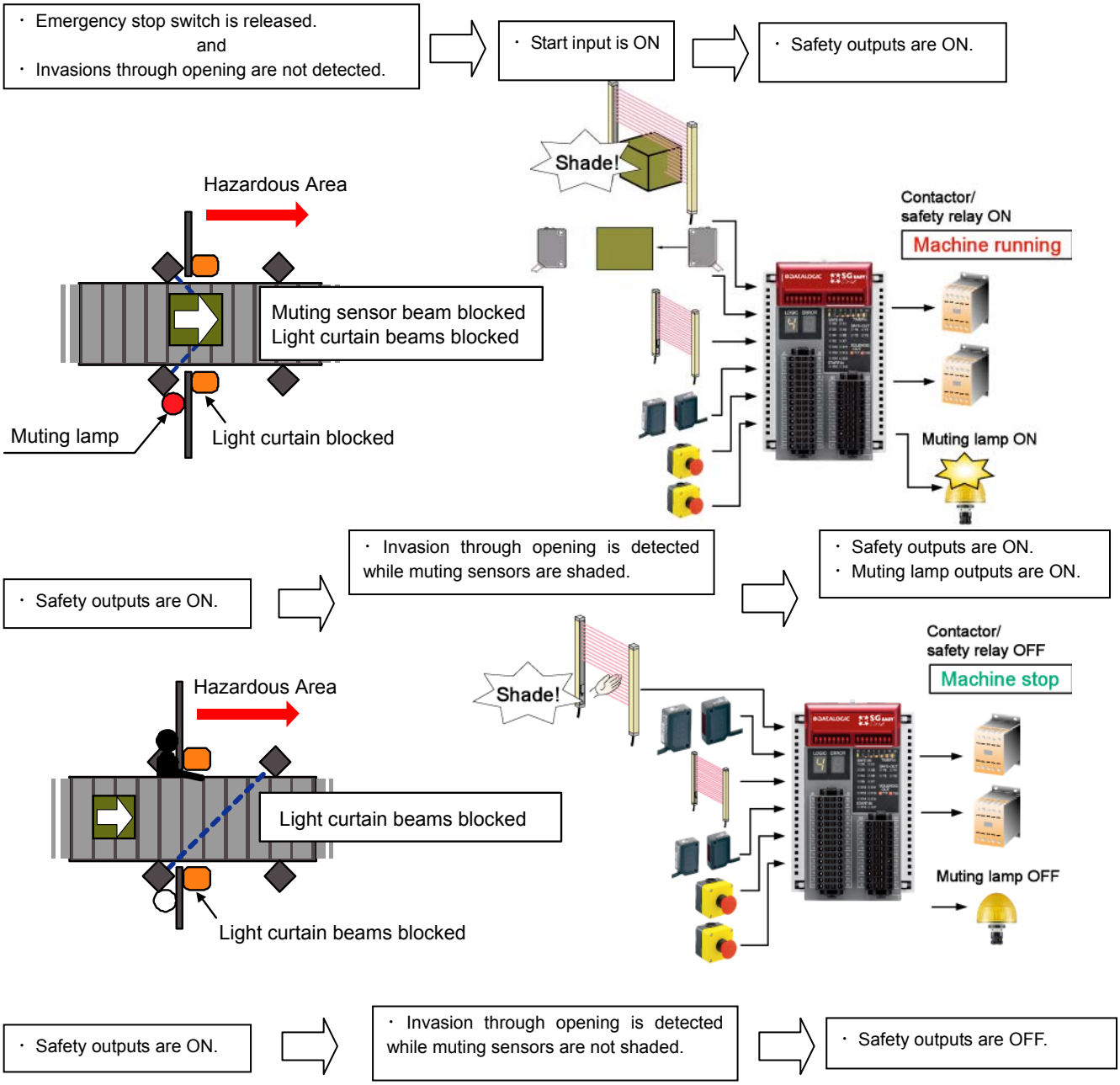
If any of the safety input signals are cut OFF while the safety outputs are ON, the safety outputs are turned OFF after the preset OFF-delay time. However, if a muting signal has been applied to X2 and X3 (X6 and X7), the safety output does not turn OFF even if the safety inputs signal to X0 and X1 (X4 and X5) are cut OFF.

## Operation example (Logic 4)



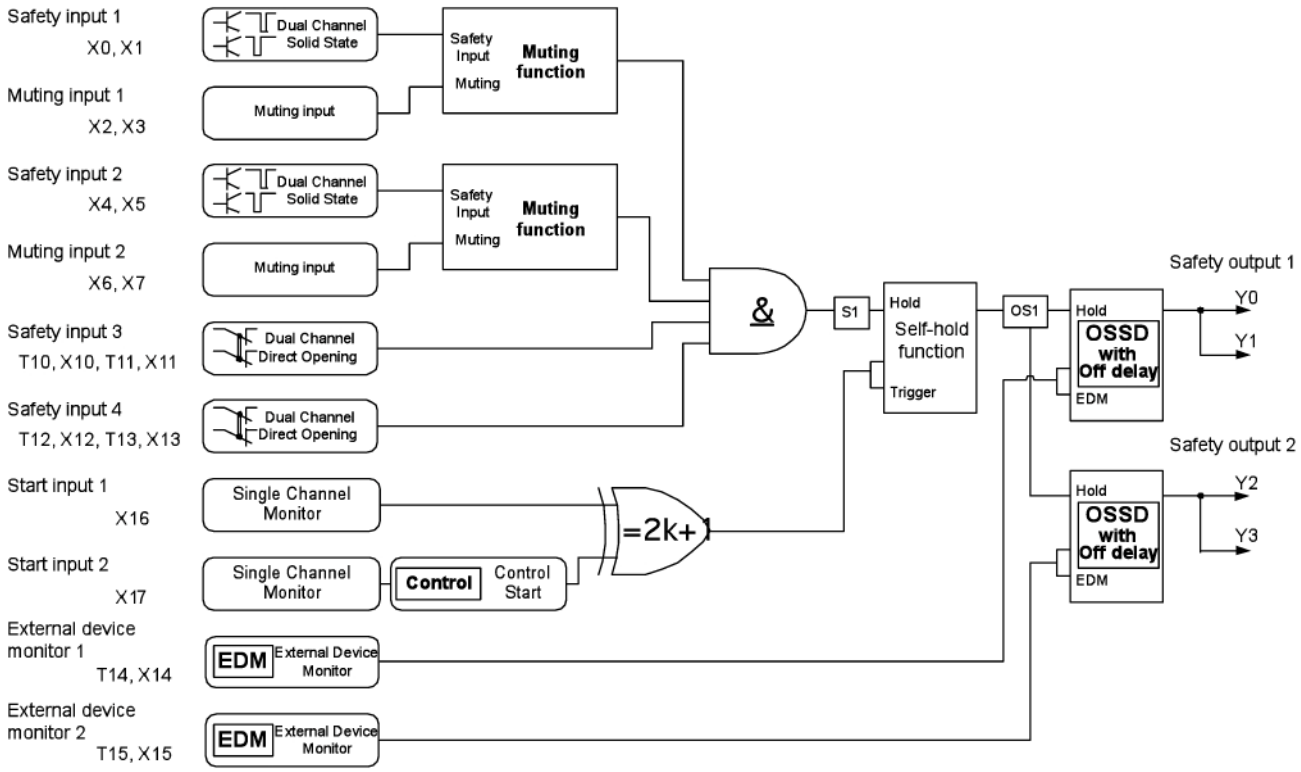




(Note) Make sure that the intersection of optical axes is within the hazardous area.

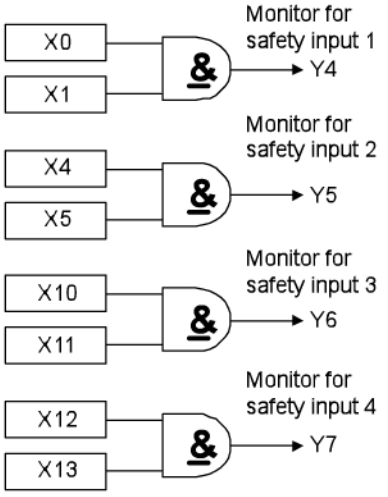



**Warning** When installing light curtains and muting sensors, ensure safety by referring to IEC TS 62046 technical documents.

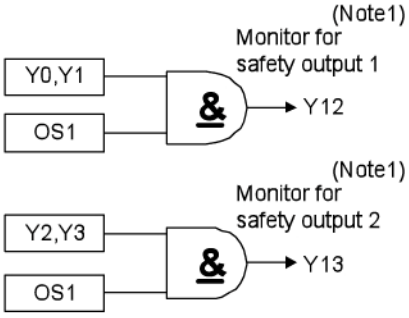
## Logic circuit (Logic 4)




- Monitor output for safety input

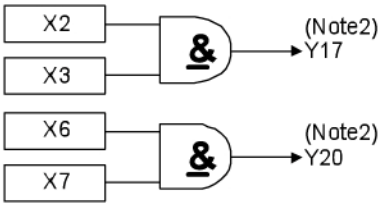



- Monitor output for safety output



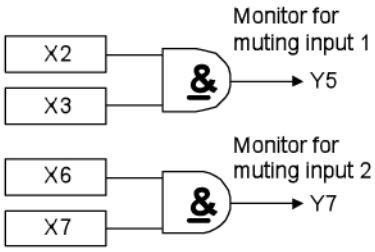

(Note1)
Monitor outputs for safety output 1 and 2 are turned OFF immediately independent of set OFF-delay time.

- Muting lamp output




(Note2)
The muting lamp outputs are turned ON when the muting function of the safety inputs are effective.
Even if the muting inputs are turning ON, the muting lamp outputs are not turned ON, when the muting functions are not effective because the muting watch time is exceeded and the safety inputs were turned OFF before turned ON the muting inputs.

- Monitor output for muting input



**●Safety inputs: X0, X1, X4, X5, X10 to X13 (T10 to T13)**

X0, X1, X4, and X5 function as dual channel solid state inputs. These enable connections of dual channel solid state output (PNP) devices.

X10 to X13 (T10 to T13) function as dual channel direct opening inputs.

The combinations of dual channel inputs are shown below. Incorrect use of these combinations will result in an error. The input monitor error detection time for dual channel solid state inputs is 0.1 s. The input monitor error detection time for dual channel direct opening inputs is 0.5 s.

For information about connected control devices, see “SAFETY PRECAUTIONS” and “Logic functions”.

X0 and X1: Safety input 1, X4 and X5: Safety input 2

X10-T10, X11-T11: Safety input 3, X12-T12, X13-T13: Safety input 4

**Warning**

Safety check signals (pulses signals) are transmitted from the drive terminals (T10 to T13) to diagnose connected safety devices and input circuits. Safety check signals can not be used as power for connected devices.

Note: Don’t use T0, T1, T4, and T5.

Note: If there are unused safety inputs, for safety input 1 or safety input 2 (receive terminals: X0,X1, X4, and X5), apply 24V DC to the terminals not connected to safety devices.

For safety input 3 and safety input 4 (receive terminals: X10 to X13, drive terminals: T10 to T13), short between the receive terminal (Xn) and the drive terminal (Tn). If this is not done, then the SG-ONE will not turn ON its safety outputs.

**●Muting inputs: X2, X3, X6, and X7**

X2, X3, X6, and X7 function as muting inputs. Muting sensors (3wire, PNP output) or limit switches can be connected as muting signal sources.

2 signals from Independent muting signal sources should be used for 1 muting input. The combinations of inputs are shown below. Incorrect use of these combinations will result in an error.

When X2 and X3 are both ON, the safety function of safety input 1 is suspended.

When X6 and X7 are both ON, the safety function of safety input 2 is suspended.

Even if the safety input that is suspended has its safety functions turned OFF, the safety outputs do not turn OFF.

The input monitor error detection time of muting inputs is 3s.

For information about connected control devices, see “SAFETY PRECAUTIONS” and “Logic functions”.

X2, X3: Muting input 1

X6, X7: Muting input 2

**Warning**

Muting inputs are not safety inputs. Do not use these to construct a safety system.

Note: Do not use T2, T3, T6, and T7

Note: If there are unused muting inputs, open those terminals.

Note: The maximum time to suspend the safety function continuously (muting monitor time) is 60s. If muting continues over 60s, the muting function is disabled, even if the muting inputs are still ON.

**●External device monitor inputs: X14 and X15 (T14 and T15)**

X14 and X15 (T14 and T15) function as external device monitor inputs.

X14 and T14 are used as contact monitors for external devices connected to Y0 and Y1.

X15 and T15 are used as contact monitors for external devices connected to Y2 and Y3.

**Warning**

Safety check signals (pulses signals) are transmitted from the drive terminals (T14,T15) to diagnose external devices and monitor circuits. The safety check signal can not be used as power for connected devices.

Note: If there are unused safety outputs, short between external device monitor terminals (Xn) corresponding to the unused safety outputs and the drive terminals (Tn). If they are not shorted, the SG-ONE detects an input monitor error. As the result, an error LED displays “1” and the state changes to the Protection state.

**●Start inputs: X16 and X17**

X16 is used to control the start of the safety outputs as an “auto start” which does not use a start switch, or “manual start” which does not detect welding of the start switch. When the start input (X16) is turned ON (the ON state of X16 must be turned on for more than 0.1s) all devices connected to the safety inputs are in the safe state, and the start condition is established.

X17 is used to control the start of the safety outputs as a “control start” which detects welding of the start switch. When the start input changes from OFF→ON→OFF (the ON state of X17 must be turned on between 0.1s to 5s) all devices connected to the safety inputs are in the safe state, and the start condition is established.

Note: If both of X16 and X17 are turned ON at the same time, the SG-ONE will detect an error. As a result, the error LED displays “3” and the state changes to the Stop state. Use either X16 or X17, but not both.

**●Safety outputs (with OFF-delay timer): Y0 to Y3**

Y0 to Y3 function as safety outputs with the OFF-delay timer. When the timer is set to “0s” (indication “1”), the safety outputs are shut OFF immediately.

Y0 and Y1: Safety output 1

Y2 and Y3: Safety output 2

**●safety input monitor outputs: Y4, Y6, Y10 and Y11**

Y4, Y6, and Y10 to Y11 function as status monitoring of safety input devices connected to the SG-ONE.

Y4 and Y6: When 24V DC is applied to both terminals of “X0 and X1” or “X4 and X5”, Y4 or Y6 are turned ON.

Y10 and Y11: When the both contacts of the safety device connected to safety output 5 and 6 are ON, the output is ON. When the both contacts are OFF, the output is OFF.

If an input monitoring error is detected, pulses (1Hz) are transmitted.

Y4 outputs the status of safety input 1 (X0 and X1).

Y6 outputs the status of safety input 3 (X4 and X5).

Y10 outputs the status of safety input 5 (X10-T10, X11-T11).

Y11 outputs the status of safety input 6 (X12-T12, X13-T13).

**●Muting input monitor outputs: Y5 and Y7**

Y5 and Y7 function as monitoring outputs that output the status of the muting signal devices connected to the SG-ONE. When 24V DC is applied to both terminals of “X2 and X3” or “X6 and X7”, either Y5 or Y7 are turned ON. If an input monitoring error is detected, pulses (1Hz) are transmitted.

Y5 outputs the status of muting input 1 (X2 and X3).

Y7 outputs the status of muting input 2 (X6 and X7).

**●Safety output monitor outputs: Y12 and Y13**

Y12 and Y13 function as monitoring outputs that output status of the safety outputs. When the safety outputs are OFF, the safety output monitoring output is turned OFF immediately, even if OFF-delay timer has been set.

Y12 outputs the status of safety output 1 (Y0 and Y1). This turns ON when Y0 and Y1 are both ON.

Y13 outputs the status of safety output 2 (Y2 and Y3). This turns ON when Y2 and Y3 are both ON.

**●State monitor outputs: Y14 to Y16**

Y14 to Y16 are monitoring outputs for the internal status of the SG-ONE.

Y14 turns ON when in Initial or Stop state.

Y15 turns ON in Initial, Protection or Configuration state.

Y16 turns ON in Run state.

Refer to “Chapter 4 BASIC OPERATION”, or “Chapter 6 TROUBLESHOOTING”, for details of each state.

**Warning**

Monitor outputs are not safety outputs. Do not use these to construct a safety system.

**●Muting lamp outputs： Y17 and Y20**

Y17 and Y20 are outputs to indicate that the safety functions of corresponded safety inputs are being suspended.

Y17 turns ON when safety function of safety input 1 is suspended.

Y20 turns ON when safety function of safety input 2 is suspended.

**Warning**

Muting lamp outputs are not safety outputs. Do not use these to construct a safety system.

Note: In Logic 4, muting lamp output terminals (Y17 and Y20) detect that connected indicator lights are disconnected or unconnected. If these failures are detected, the error LED displays “5” and the state changes to the Stop state.

When not using the muting function, connect a resistor (10 kΩ, 1/4W) to these terminals.

**Caution**

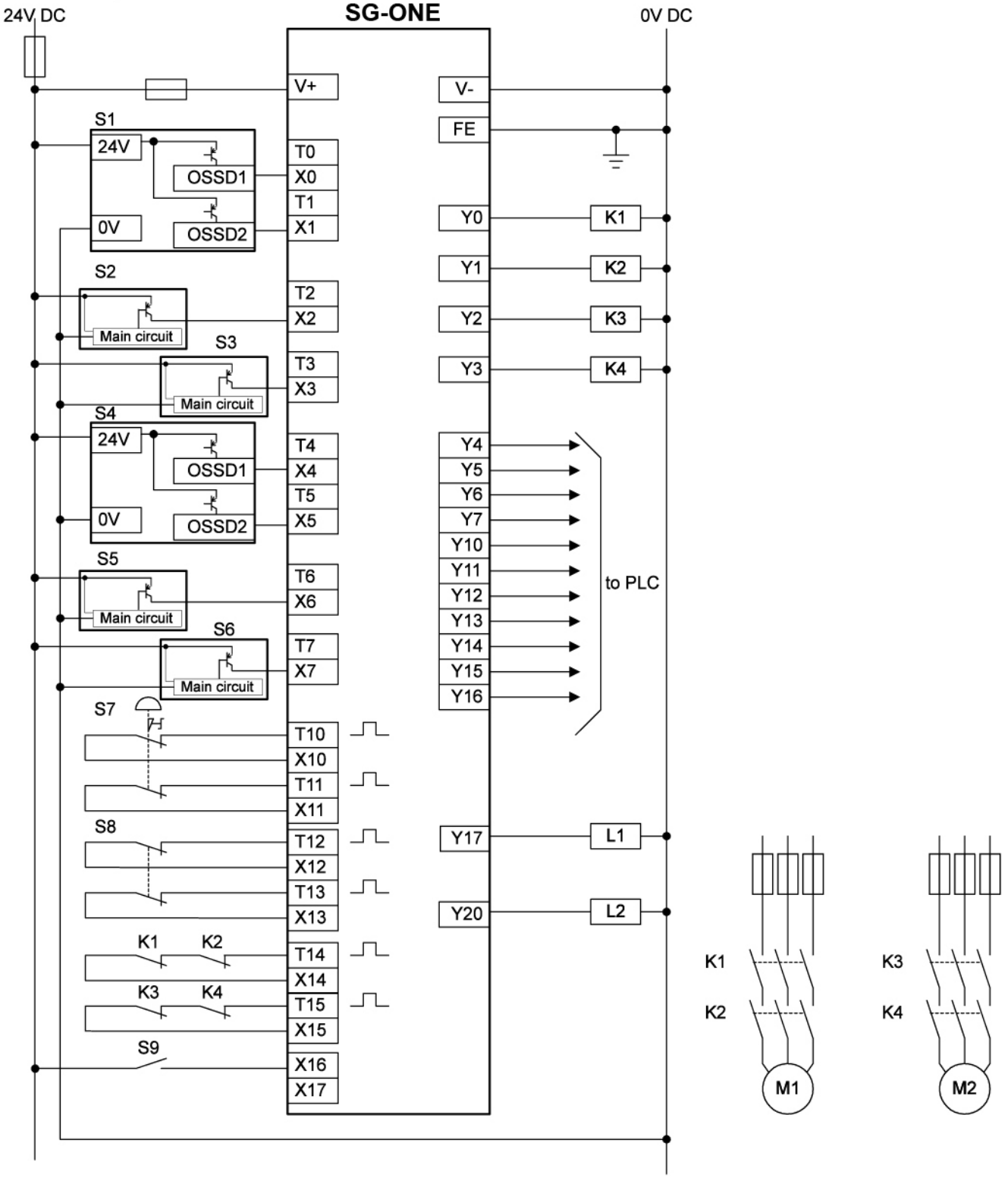
Refer to "Chapter 2 PRODUCT SPECIFICATIONS" for specifications of each input and output.

## Wiring example (Logic 4)

**2 safety light curtains and 4 muting sensors and 1 emergency stop switch and 1 safety switch are connected.**

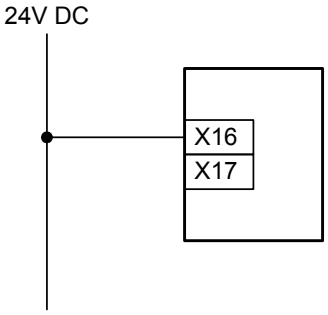
S1,4 :Safety light curtain
S2,3,5,6 :Muting sensor
S7 :Emergency stop switch
S8 :Safety switch
S9 :Start switch
K1...4 :Contactor
L1,2 :Muting lamp
M1,2 :Motor

Fuse



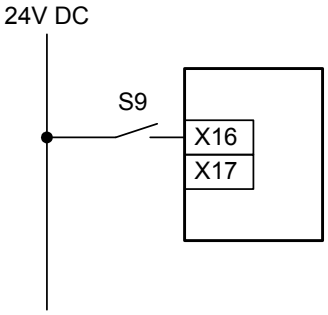
**When not using the start switch**

**Auto start**



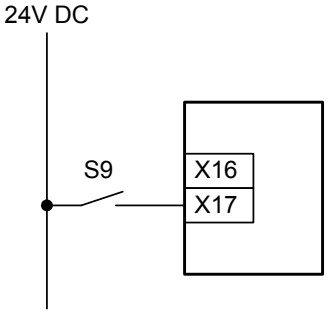

**When not detecting the welding of start switch**

**Manual Start**

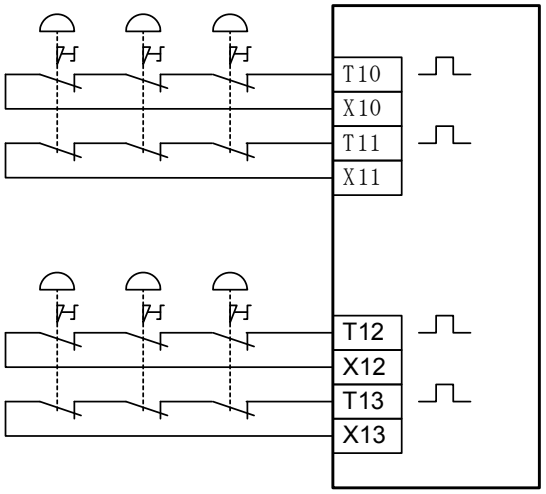



**When detecting the welding of start switch**

**Control start**

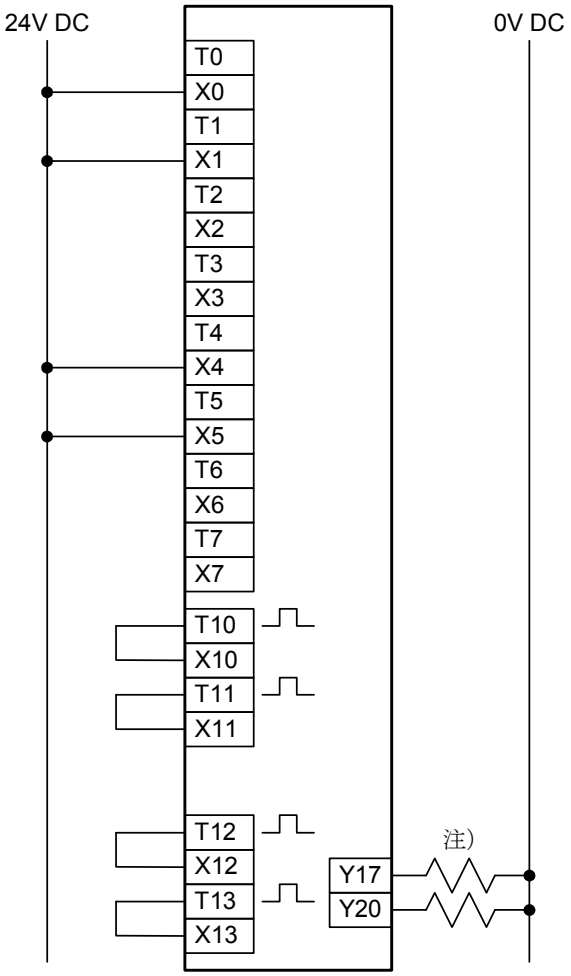



**When connecting multiple emergency stop switches in series**




NOTE: Applicable safety performance is dependent upon each system configuration.

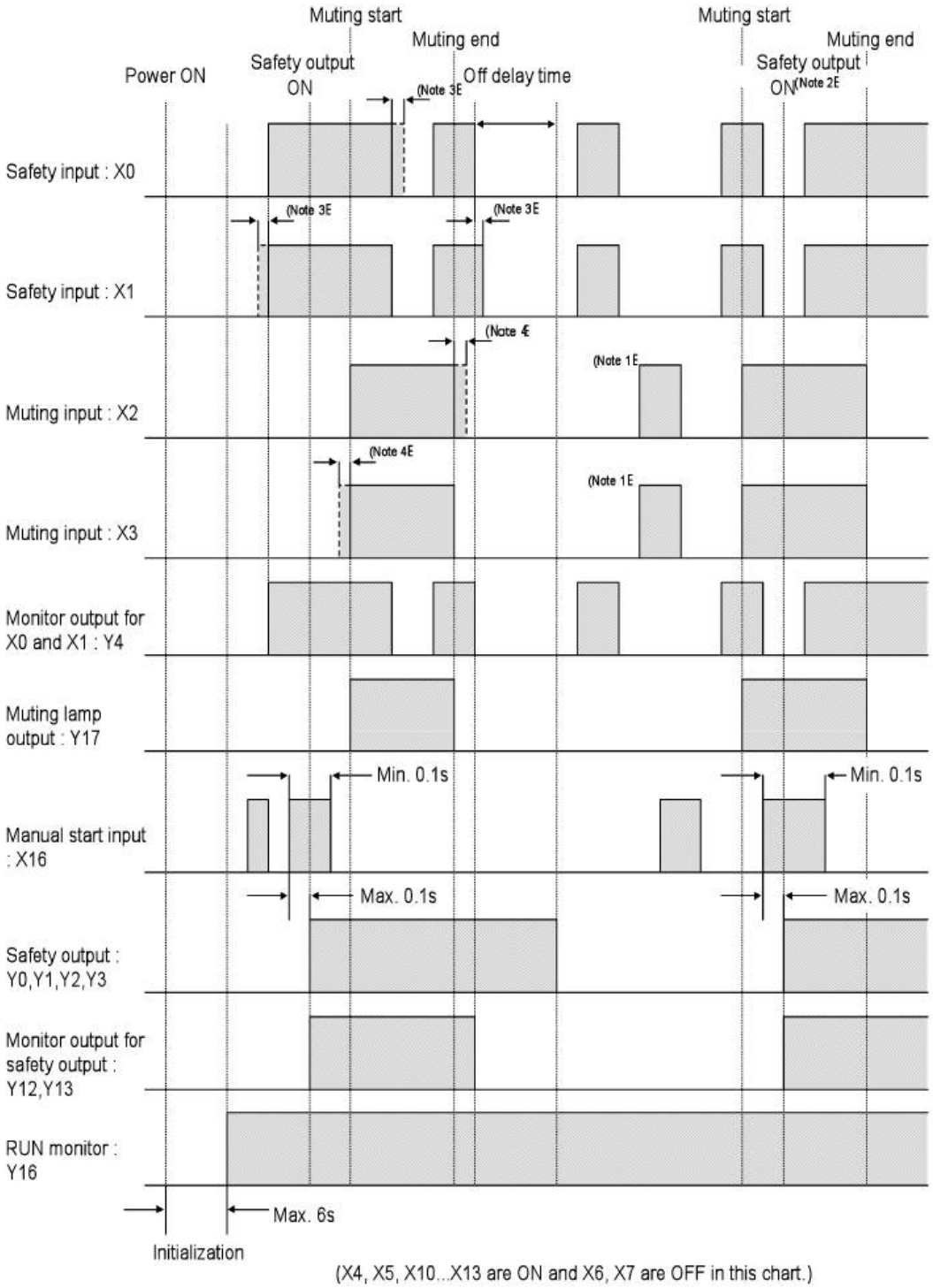
**When not using some safety inputs**




NOTE: In Logic 4,the muting lamp output terminals (Y17 and Y20) detect that connected indicator lights are disconnected or unconnected.
When not using the muting function, connect a resistor across these terminals.
If no resistor is connected, then the SafetyOne detects any wiring errors and locks out operations.

## Timing chart (Logic 4)

1.Example of using the manual start input (X16)




(X4, X5, X10...X13 are ON and X6, X7 are OFF in this chart.)

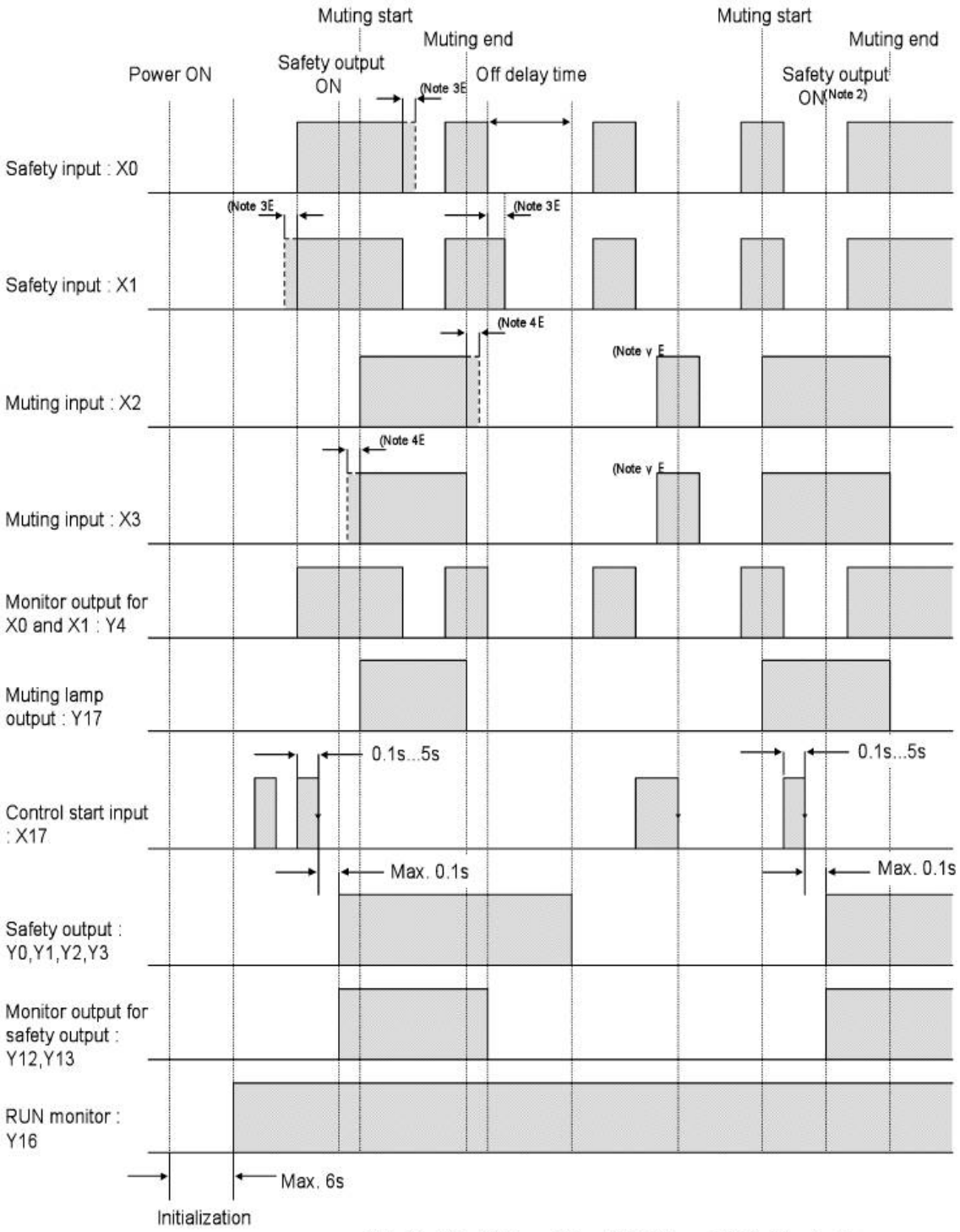
Note 1: When the safety inputs were turned OFF before the muting inputs were turned ON, the muting functions are not effective and the safety outputs are not turned ON.

Note 2: When the muting inputs are turned ON while the safety inputs are ON, the muting functions are effective and the safety outputs are turned ON upon input of the start input.

Note 3: When the input time difference at the dual channel solid state inputs (X0-X1, X4-X5) is greater than 0.1s input monitor error is detected.
When the input time difference at thdual channel direct opening inputs(X10-X11, X12-X13) is greater than 0.5s input monitor error is detected.
Refer to the following "Logic functions" for details.

Note 4: When the input time difference at the muting inputs (X2-X3, X6-X7) is greater than 3s input monitor error is detected.
Refer to the following "Logic functions" for details.

2.Example of using the control start input (X17)




(X4, X5, X10...X13 are ON and X6, X7 are OFF in this chart.)

Note 1: When the safety inputs were turned OFF before the muting inputs were turned ON, the muting functions are not effective and the safety outputs are not turned ON.

Note 2: When the muting inputs are turned ON while the safety inputs are ON, the muting functions are effective and the safety outputs are turned ON upon initiation of the start input.

Note 3: When the input time difference at the dual channel solid state inputs (X0-X1 and X2-X3) is greater than 0.1s input monitor error is detected.
When the input time difference at the dual channel direct opening inputs (X4-X5, X6-X7, X10-X11, and X12-X13) is greater than input monitor error is detected.
Refer to the following "Logic functions" for details.

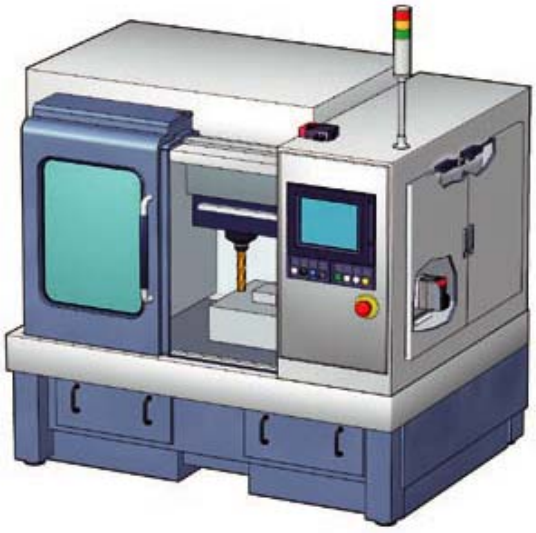
Note 4: When the input time difference at the muting inputs (X2-X3, X6-X7) is greater than 3s an input monitor error is detected.
Refer to the following "Logic functions" for details.

# Logic 5: General purpose logic for devices for which sync time between contacts cannot be specified

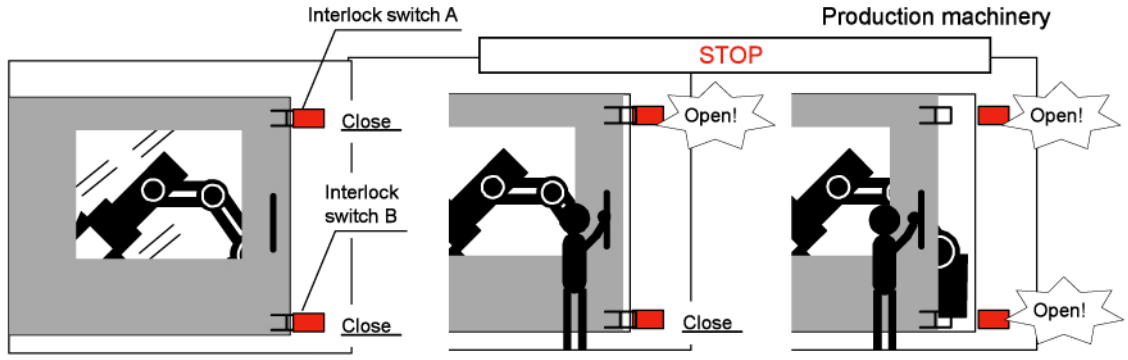
## Overview (Logic 5)

The logic described is for safety protective measures applicable to production machinery, robots, and other machinery. This logic enables the connection 6 dual channel dependent inputs.

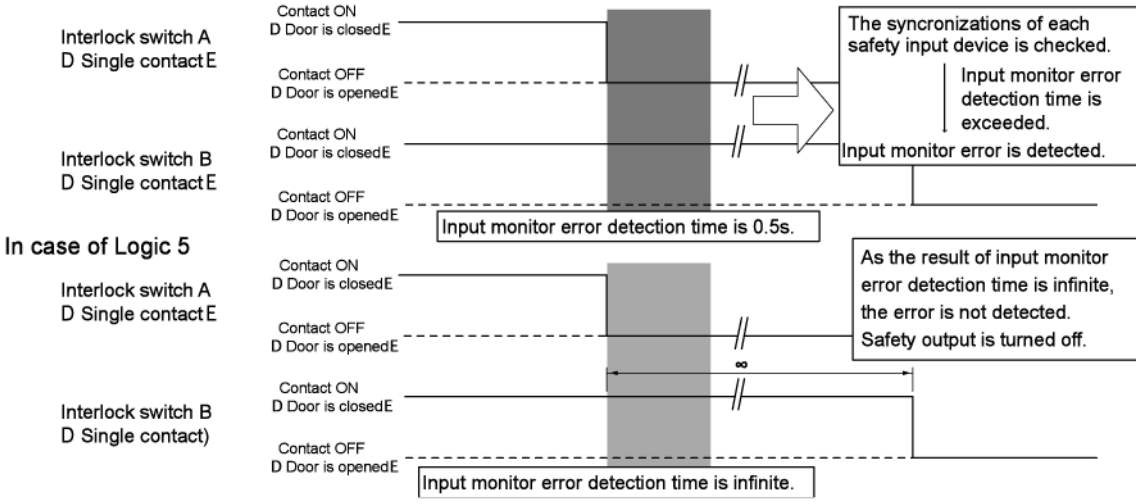
Same as Logic 1, when SG-ONE is in the safe state, all of the safety inputs can receive safety input signals (the contacts of all connected safety devices are ON), safety outputs are turned ON upon input of the start input. While the safety outputs are ON, if the safety input signal to any input of the safety inputs has been turned OFF (the contacts of any the safety devices are OFF), the safety outputs are turned OFF after the preset OFF-delay time. The difference from Logic 1 is that the input monitoring error detection time in Logic 5 is infinite, so safety functions can be performed independent of the speed of opening the guard.



## Operation example (Logic 5)

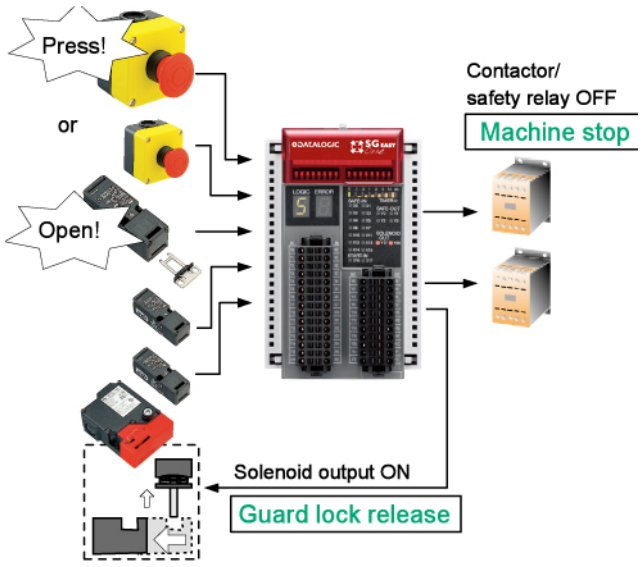



In case of Logic 1


Interlock switch A
D Single contactE
Interlock switch B
D Single contactE
Contact ON
D Door is closedE
Contact OFF
D Door is openedE
Contact ON
D Door is closedE
Contact OFF
D Door is openedE
The syncronizations of each safety input device is checked.
Input monitor error detection time is exceeded.
Input monitor error is detected.
Input monitor error detection time is 0.5s.

In case of Logic 5


Interlock switch A
D Single contactE
Interlock switch B
D Single contact)
Contact ON
D Door is closedE
Contact OFF
D Door is openedE
Contact ON
D Door is closedE
Contact OFF
D Door is openedE
As the result of input monitor error detection time is infinite, the error is not detected.
Safety output is turned off.
∞
Input monitor error detection time is infinite.

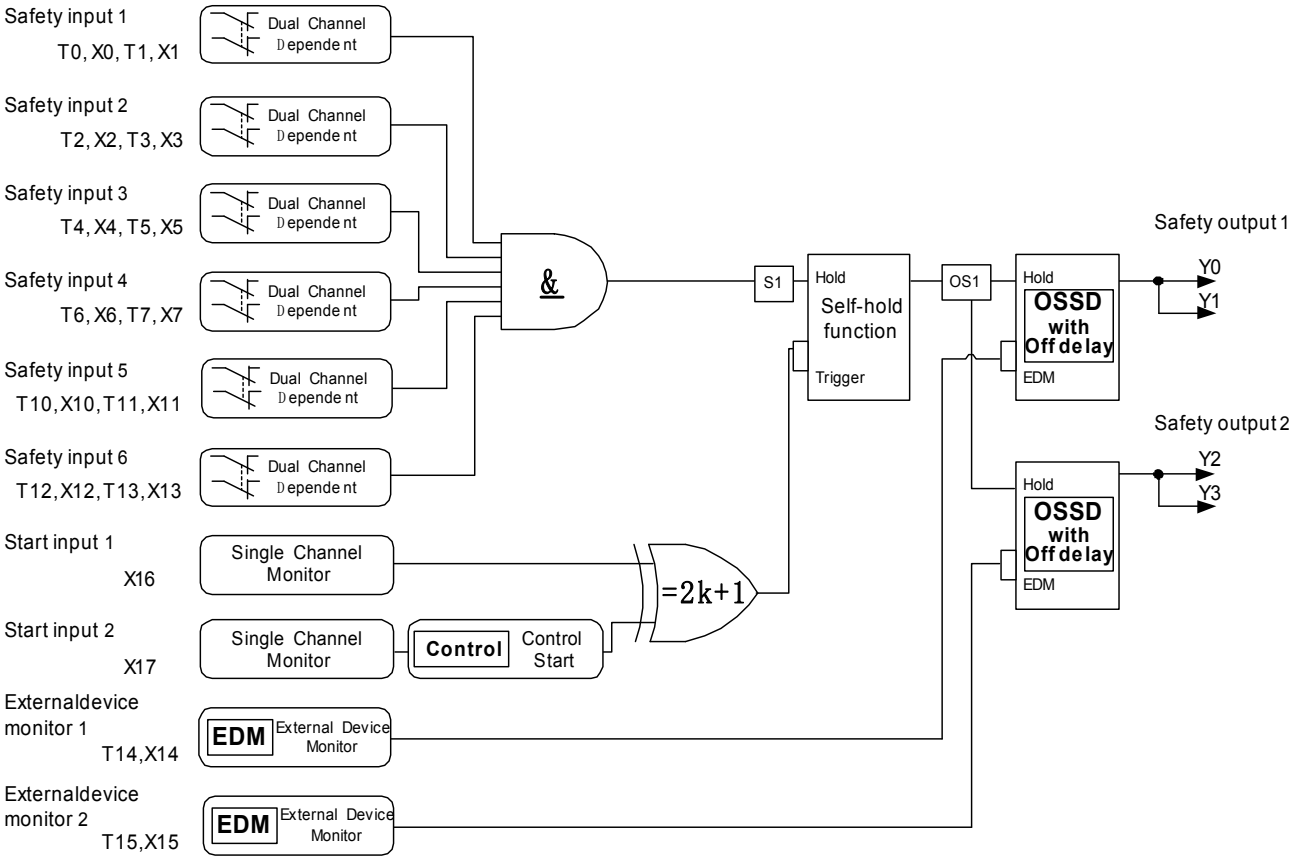



| | | |
|---|---|---|
| ・ Safety outputs are ON. | ⇨ | ・ Emergency stop switch is pressed<br>or<br>・ Movable guard is opened.<br>(Contacts of 1 of the interlock switches are OFF) |

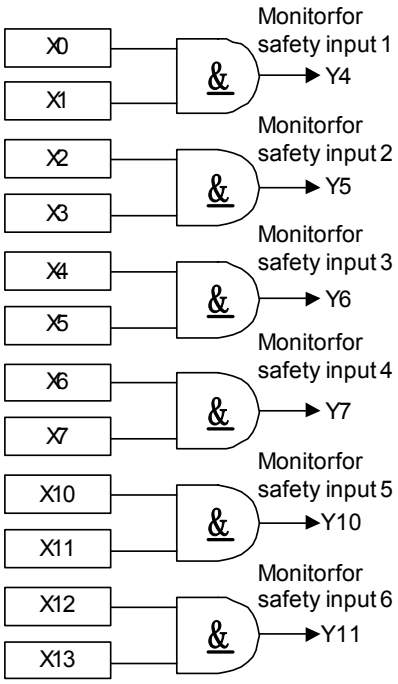
⇨

| |
|---|
| ・ Safety outputs are OFF.<br>・ Solenoid outputs are ON. |

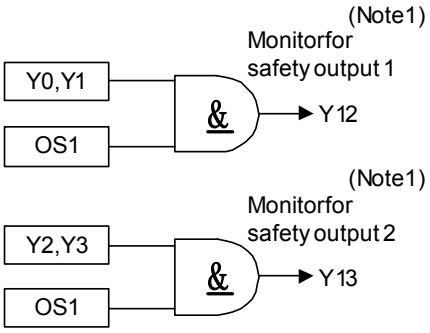
## Logic circuit (Logic 5)




### ●Monitor output for safety input



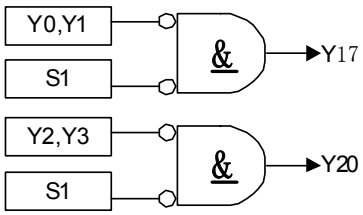

### ●Monitor output for safety output




Note1:
Monitor outputs for safety output 1 and 2 are turned OFF immediately independent of set OFF-delay time.

### ●Solenoid output

(Note2)




Note2:
In Run state, when the safety outputs are OFF and 1 or more safety inputs are OFF, the solenoid outputs are turned ON.
When all safety inputs are ON, the solenoid outputs are turned OFF, although start input is OFF.

## Functions (Logic 5)

**●Safety inputs: X0 to X13 (T0 to T13)**

X0 to X13 (T0 to T13) function as dual channel dependent inputs.

The combinations of dual channel inputs are shown below. Incorrect use of these combinations will result in an error. The input monitor error detection time between dual channel inputs is infinite.

For operation of only 1 contact of a dual channel dependent input, the behavior of SG-ONE is,

-ON→OFF→ON: Input monitor error is detected, and the state changes to the Protection state.

-OFF→ON→OFF: The state changes to the Protection state temporarily, after that, the state is restored to Run state immediately.

(In these cases, the input monitor error detection time is 0.1s.)

For information about connected control devices, see “SAFETY PRECAUTIONS”.

X0-T0, X1-T1: Safety input 1 (If 1 or both contacts are OFF, the safety input is OFF.)
X2-T2, X3-T3: Safety input 2 (If 1 or both contacts are OFF, the safety input is OFF.)
X4-T4, X5-T5: Safety input 3 (If 1 or both contacts are OFF, the safety input is OFF.)
X6-T6, X7-T7: Safety input 4 (If 1 or both contacts are OFF, the safety input is OFF.)
X10-T10, X11-T11: Safety input 5 (If 1 or both contacts are OFF, the safety input is OFF.)
X12-T12, X13-T13: Safety input 6 (If 1 or both contacts are OFF, the safety input is OFF.)

Safety check signals (pulses signals) are sent from the drive terminals (T0 to T13) to diagnose the connected safety devices and the input circuits. Safety check signals can not be used as power for the connected devices.

Note: Solid state outputs, such as safety light curtains, can not be connected.

Note: If there are unused safety inputs, short between the receive terminals (Xn) corresponding to the unused safety inputs and the drive terminals (Tn). If they are not shorted, the SG-ONE will not turn ON the safety outputs.

**●External device monitor inputs: X14 and X15 (T14 and T15)**

X14 and X15 (T14 and T15) function as external device monitoring inputs.

X14 and T14 are used as contact monitoring for external devices connected to Y0 and Y1.

X15 and T15 are used as contact monitoring for external devices connected to Y2 and Y3.

Safety check signals (pulses signals) are sent from the drive terminals (T14, T15) to diagnose the external devices and the monitor circuits. The safety check signal can not be used as a power for connected devices.

Note: If there are unused safety outputs, short between the external device monitor terminals (Xn) corresponding to the unused safety outputs and the drive terminals (Tn). If they are not shorted, the SG-ONE detects an input monitor error. As the result, the error LED displays “1” and the state changes to the Protection state.

**●Start inputs: X16 and X17**

X16 is used to control the start of the safety outputs as an “auto start” which does not use a start switch, or a “manual start” which does not detect welding of the start switch. When the start input (X16) is turned ON (the ON state of X16 must be on longer than 0.1s) all devices connected to the safety inputs are in safe state, the start condition is established.

X17 is used to control the start of the safety outputs as a “control start” which detects welding of the start switch. When the start input changes from OFF→ON→OFF (the ON state must be kept on from 0.1s to 5s) all devices connected to the safety inputs are in safe state, the start condition is established.

Note: If both of X16 and X17 are turned ON, the SG-ONE will detect an error. As the result, the error LED displays “3” and the state changes to the Stop state. Use only either X16 or X17, but not both at the same time.

**●Safety outputs (with OFF-delay timer): Y0 to Y3**

Y0 to Y3 function as safety outputs with the OFF-delay timer. When the timer is set to “0s” (indication “1”), the safety outputs shut OFF immediately.

Y0 and Y1: Safety output 1
Y2 and Y3: Safety output 2

**●Safety input monitor outputs: Y4 to Y11**

Y4 toY11 function as status monitors of safety input devices connected to the SG-ONE.
When the both contacts of the safety device are ON, the output is ON; when 1 or more contacts are OFF, the output is OFF.
If input monitoring errors are detected, pulses (1Hz) are transmitted.

Y4 outputs the status of safety input 1 (X0-T0, X1-T1).
Y5 outputs the status of safety input 2 (X2-T2, X3-T3).
Y6 outputs the status of safety input 3 (X4-T4, X5-T5).
Y7 outputs the status of safety input 4 (X6-T6, X7-T7).
Y10 outputs the status of safety input 5 (X10-T10, X11-T11).
Y11 outputs the status of safety input 6 (X12-T12, X13-T13)

**●Safety output monitor outputs: Y12 and Y13**

Y12 and Y13 function as monitoring outputs that output the status of the safety outputs. When the safety outputs are OFF, the monitor output turns OFF immediately, even if the OFF-delay timer has been set.

Y12 outputs the status of safety output 1 (Y0 and Y1). This turns ON when Y0 and Y1 are both ON.

Y13 outputs the status of safety output 2 (Y2 and Y3). This turns ON when Y2 and Y3 are both ON.

**●State monitor outputs: Y14 to Y16**

Y14 to Y16 are monitoring outputs for the internal status of the SG-ONE.
Y14 turns ON when in Initial or Stop state.

Y15 turns ON in Initial, Protection or Configuration state.
Y16 turns ON when in Run state.
Refer to “Chapter 4 BASIC OPERATION”, or “Chapter 6 TROUBLESHOOTING”, for details of the each state.

**Warning**

The monitor outputs are not safety outputs. Do not use these to construct a safety system.

**●Solenoid outputs: Y17 and Y20**

Y17 and Y20 are outputs for solenoid control that are used for a safety switch with a lock.
In the Run state, when the safety outputs are OFF and 1 or more safety inputs are OFF, the solenoid outputs are turned ON. When all safety inputs are ON, the solenoid outputs are turned OFF, although the start input is not activated.

**Warning**

Solenoid outputs are not safety outputs. Do not use these to construct a safety system.

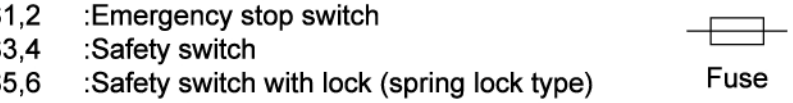
**Caution**

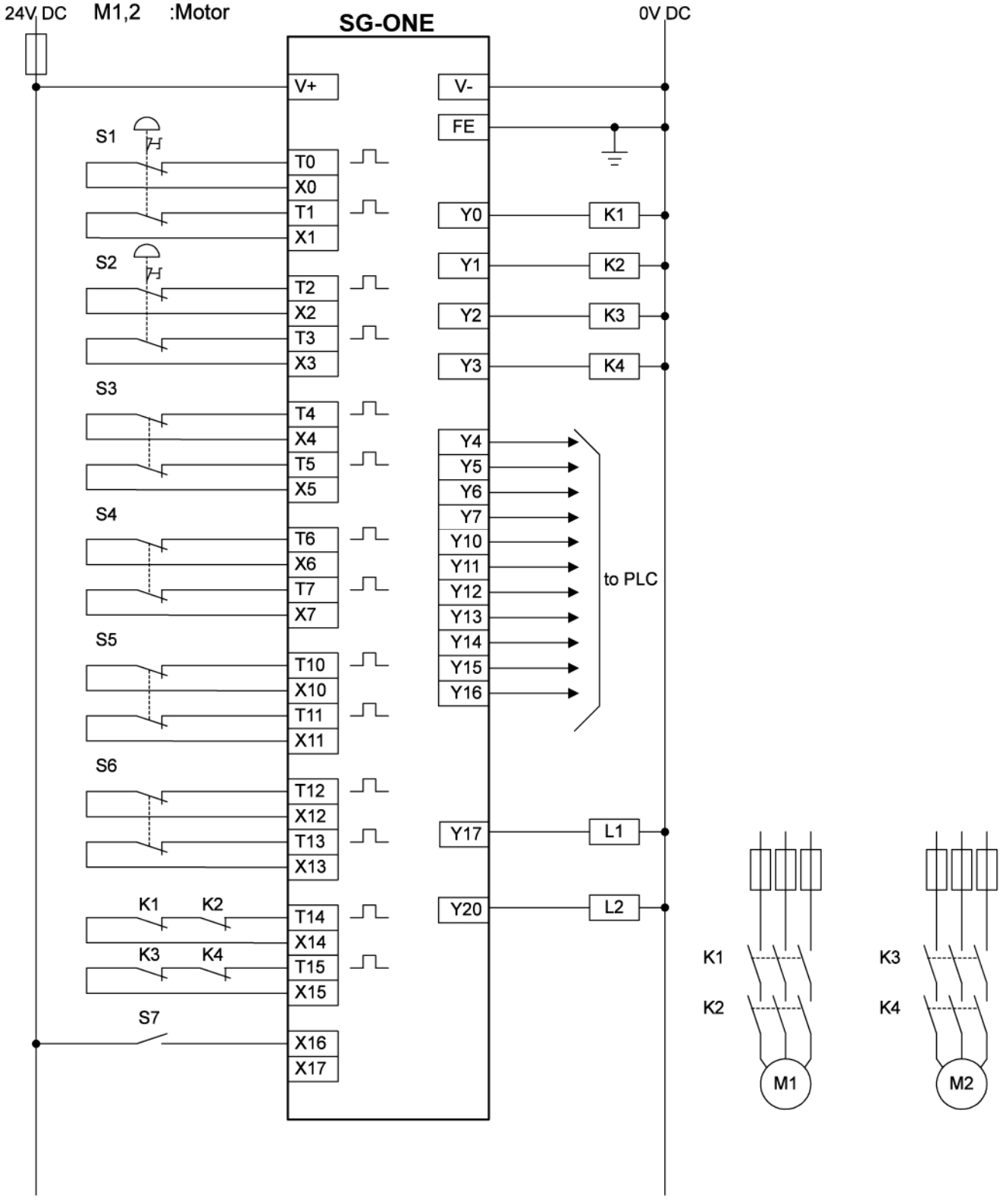
Refer to "Chapter 2 PRODUCT SPECIFICATIONS" for specifications of each input and output.

## Wiring example (Logic 5)

**Example of 2 emergency stop switches, 2 interlock switches and 2 safety switches with lock are connected.**

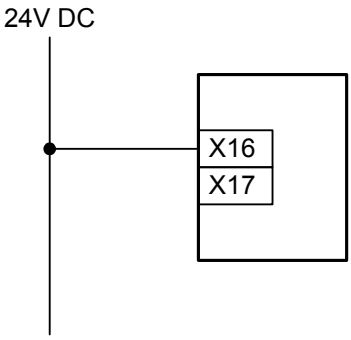
S1,2 :Emergency stop switch
S3,4 :Safety switch
S5,6 :Safety switch with lock (spring lock type)
S7 :Start switch
K1...4 :Contactor
L1,2 :Solenoid of safety switch for lock release
M1,2 :Motor



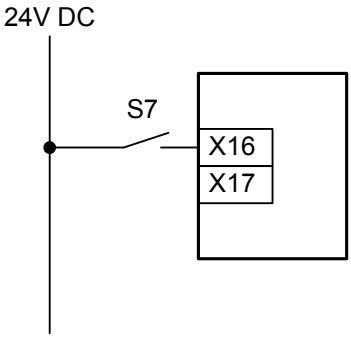
**When not using the start switch**

**Auto start**



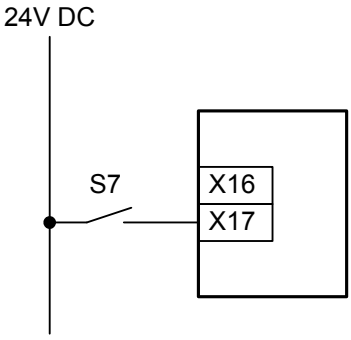

**When not detecting the welding of start**

**Manual Start**

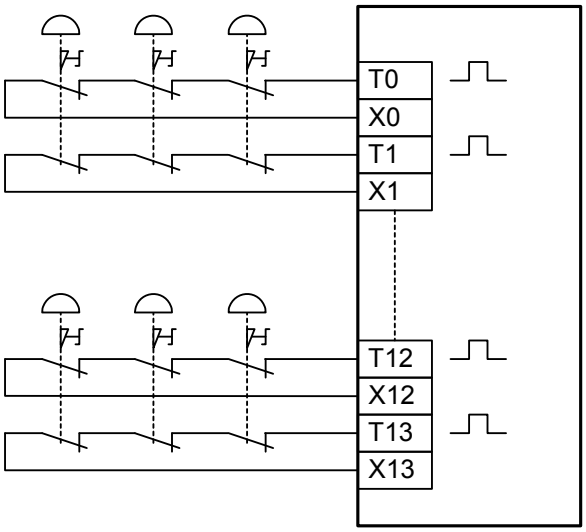



**When detecting the welding of start switch**

**Control start**

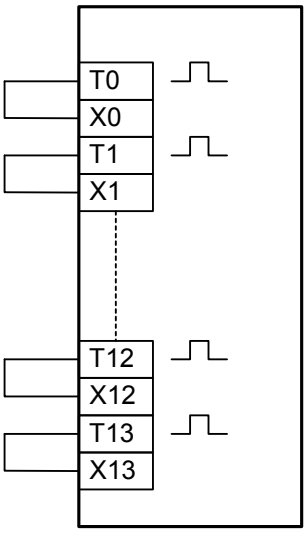



**When connecting multiple emergency stop switches in series**




NOTE: Applicable safety performance is dependent upon system configuration.

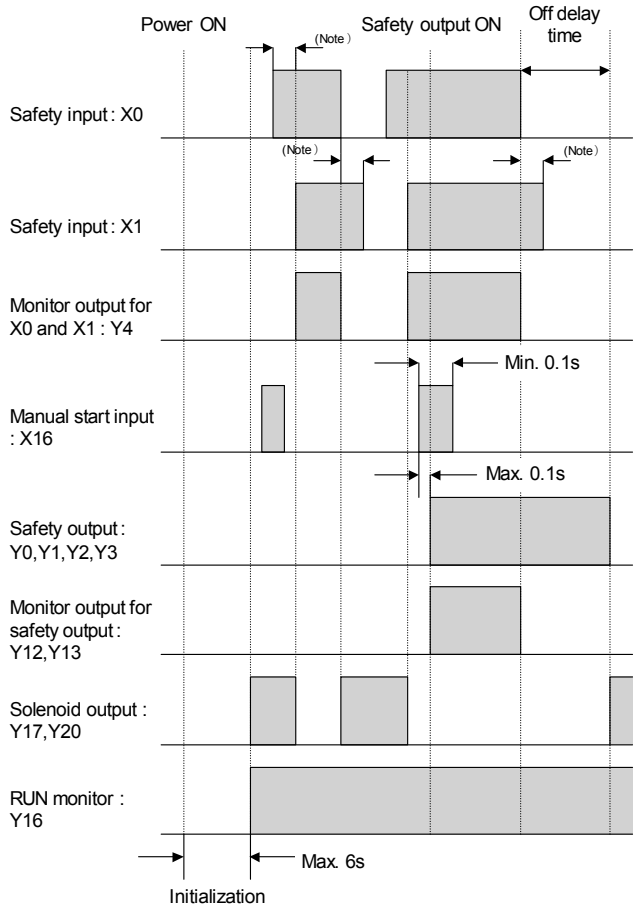
**When not using some safety inputs**




Note: If using a spring lock type safety switch as the safety input of SG-ONE, if the solenoid output of SG-ONE is connected to the solenoid power terminal of the safety switch directly, then the start condition cannot be established due to the safety input being in the OFF state. In this case, connect the switch or other equipment to the solenoid output of SG-ONE, and perform the OFF operation of the solenoid for lock control.

## Timing chart (Logic 5)

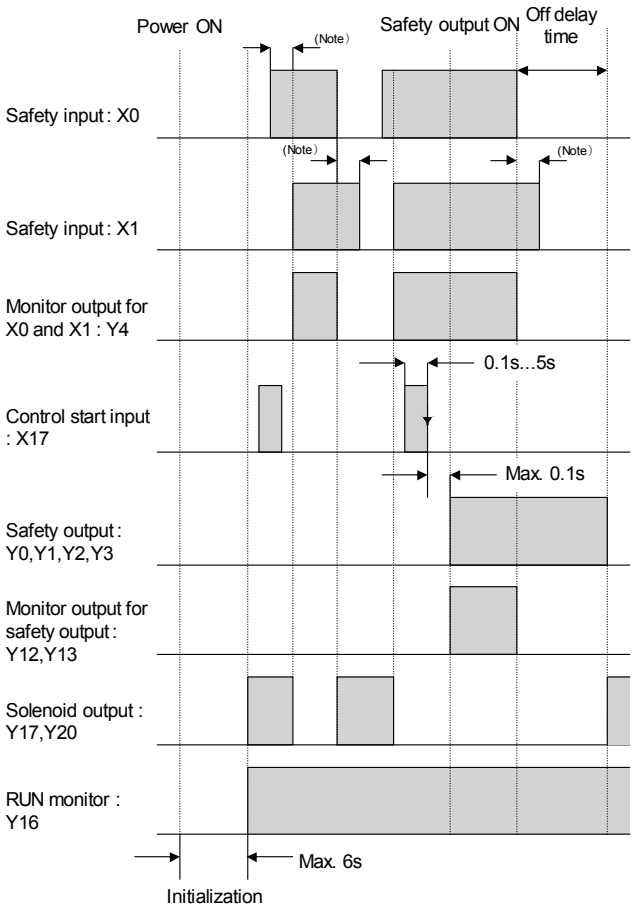
1.Example of using the manual start input (X16)




(X2...X13 are ON in this chart.)

Note: The detection time of input monitor error is infinite.
Refer to the following “Logic functions” for details.

2.Example of using the control start input (X17)




(X2...X13 are ON in this chart.)

# Logic 6: The logic applicable for selection of an active safety input device

## Overview (Logic 6)

For production machines, robots, and the like, a hazard is generally isolated by a usual protective door (guard); however, when performing maintenance, the machine is operated in the condition that a person is in the danger zone. For such a situation, the logic described is applicable to the mode selection between teach mode (maintenance mode) and the auto mode (operating mode). This logic enables the connection of 1 mode select input, a dual channel dependent input, and a four dual channel direct opening input.

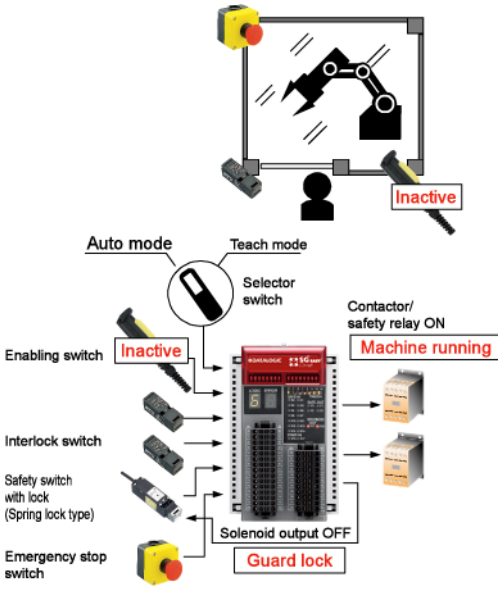
While SG-ONE is in the teach mode, if safety inputs 2 (active only in teach mode), 5 and 6 (always active) can receive safety input signals (all contacts of the safety devices are ON), safety outputs are turned ON upon input of the start input. While the safety outputs are ON, if the safety input signal to any of the safety inputs 2, 5 or 6 have been turned OFF (the contact of any safety device is OFF), the safety outputs are turned OFF after the preset OFF-delay time has elapsed.

When SG-ONE is in auto mode, if safety inputs 3, 4 (active only in auto mode) 5, and 6 (always active) can receive safety input signals (all contacts of the safety devices are ON), safety outputs are turned ON upon input of the start input. While the safety outputs are ON, if the safety input signal to any input of the safety input 3, 4, 5 or 6 have been turned OFF (the contact of any safety device is OFF), the safety outputs are turned OFF after the preset OFF-delay time has elapsed.

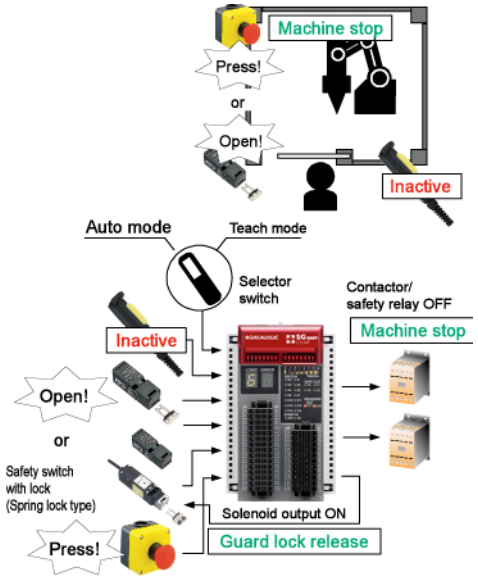
## Operation example (Logic 6)

- Auto mode (Operating mode)

Machine running




Machine stop (Safe state)




・ Safety outputs are ON.

→

・ Emergency stop switch is pressed

or

・ Movable guard is opened.

(Contacts interlock switches are OFF)

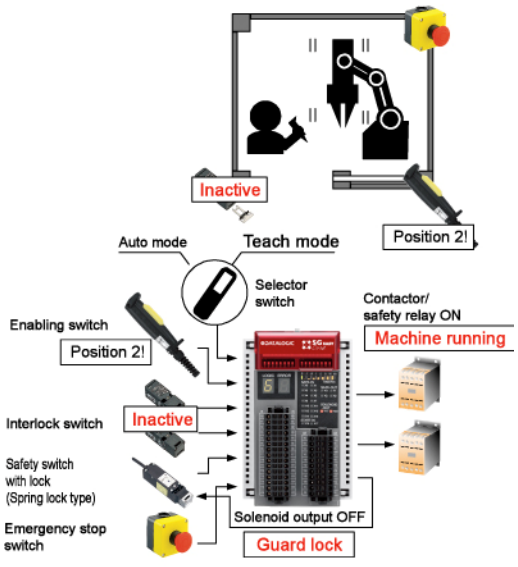
→

・ Safety outputs are OFF.

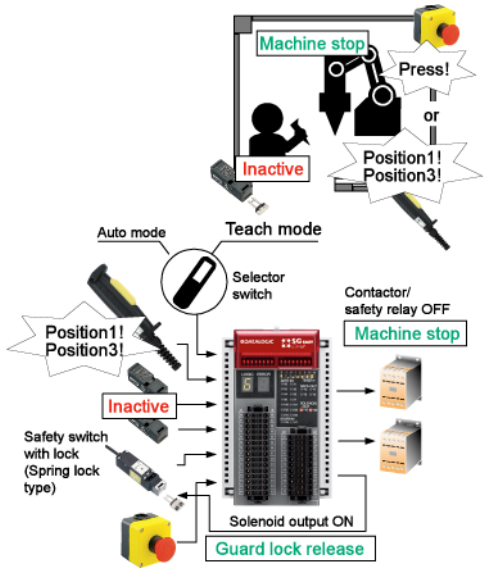
・ Solenoid outputs are ON.

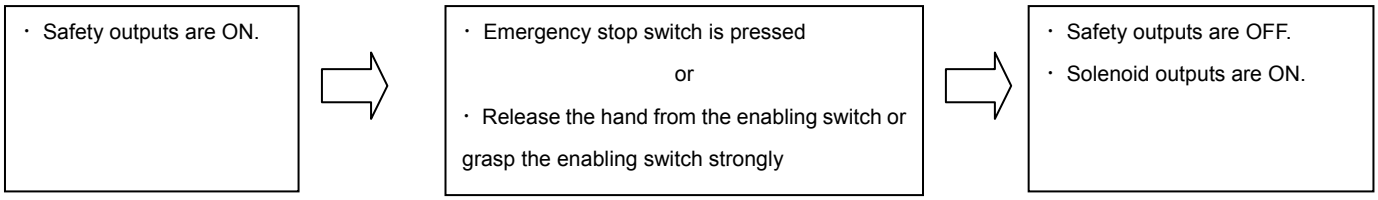
- Teach mode (operating mode)

Machine running

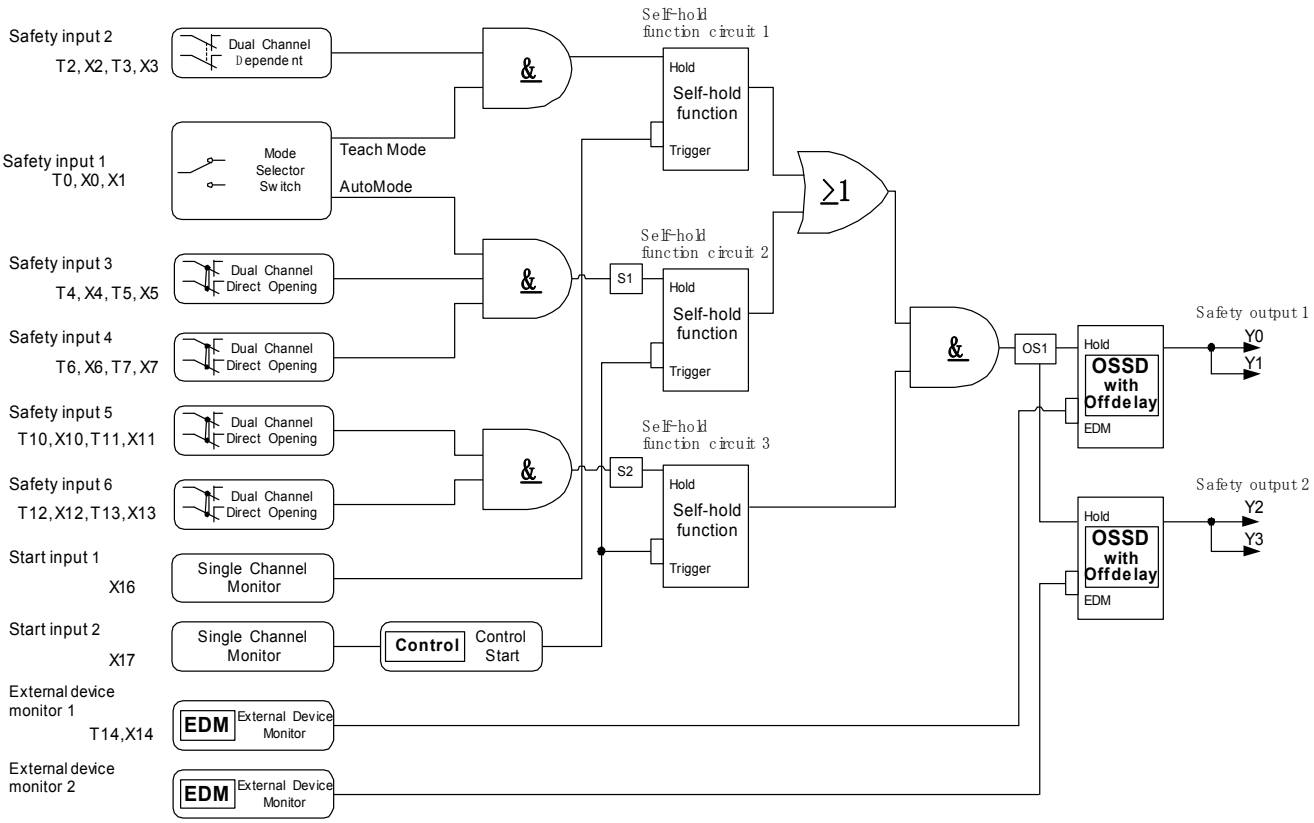



Machine stop (Safe state)

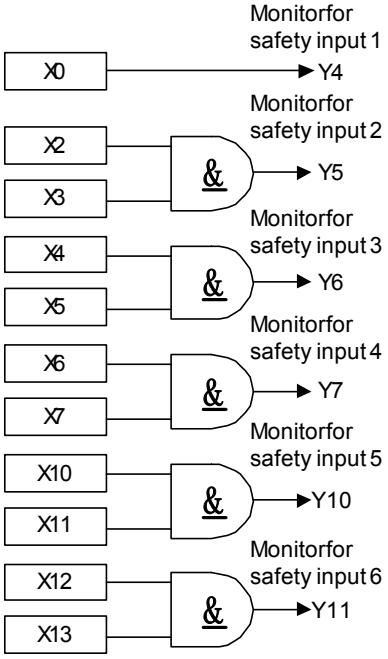



・ Safety outputs are ON.
・ Emergency stop switch is pressed
or
・ Release the hand from the enabling switch or grasp the enabling switch strongly
・ Safety outputs are OFF.
・ Solenoid outputs are ON.

## Logic circuit (Logic 6)

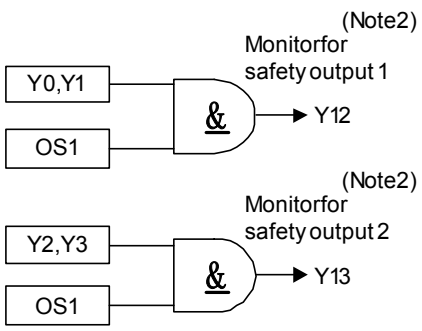



### ●Monitor output for safety input (Note1)



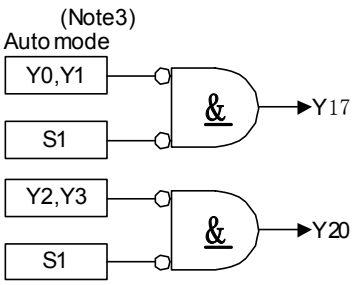

Note1:
When safety input 1 is Auto mode, the monitor for safety input 1 is turned OFF.

### ●Monitor output for safety output



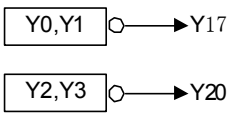

Note2:
Monitor outputs for safety output 1 and 2 are turned OFF immediately independent of set OFF-delay time.

### ●Solenoid output




Note3:
Auto mode:
In Run state, when the safety outputs are OFF and 1 or more corresponding safety inputs are OFF, the solenoid outputs are turned ON.
When all corresponding safety inputs are ON, the solenoid outputs are turned OFF without ON signal of the start input.

(Note4)
Teach mode




Note4:
Teachmode:
In Run state, when the safety outputs are OFF, the solenoid outputs are turned ON.

## Functions (Logic 6)

- **Safety inputs: X0 to X13 (T0 to T13)**

  X0 and X1 (T0) function as mode select inputs.
  X2 and X3 (T2 and T3) function as dual channel dependent inputs.
  X4 to X13 (T4 to T13) function as dual channel direct opening inputs.
  The combinations of inputs are shown below. Incorrect use of these combinations will result in an error. The input monitor error detection time for dual channel direct opening inputs is 0.5 s. The input error monitor detection time for dual channel dependent inputs is infinite.
  For the operation of 1 contact of the dual channel dependent inputs, the behavior of SG-ONE is,
  -ON→OFF→ON: Input monitor error is detected, and the state changes to the Protection state.
  -OFF→ON→OFF: The state changes to the Protection state temporarily, and after that, the state is restored to the Run state immediately.
  (In these cases, the input monitor error detection time is 0.1s.)
  For information about connected control devices, see “SAFETY PRECAUTIONS”

  X0-T0, X1-T0: Safety input 1 (If X0 is ON, the selected mode is teach mode. If X1 is ON, the selected mode is auto mode.)
  X2-T2, X3-T3: Safety input 2 (Active only in teach mode. However input monitor error can be detected in auto mode, too. If 1 or both contacts are OFF, the safety input is OFF.)
  X4-T4, X5-T5: Safety input 3 (Active only in auto mode. However input monitor error can be detected in teach mode, too.)
  X6-T6, X7-T7: Safety input 4 (Active only in auto mode. However input monitor error can be detected in teach mode, too.)
  X10-T10, X11-T11: Safety input 5 (Always active)
  X12-T12, X13-T13: Safety input 6 (Always active)

  **Warning**

  Safety check signals (pulses signals) are transmitted from the drive terminals (T0, T2 to T13) to diagnose connected safety devices and input circuits. Safety check signals can not be used as power for connected devices.

  Note: Solid state outputs, such as safety light curtains, can not be connected.

  Note: Do not use T1.

  Note: If there are unused safety inputs in safety input 2 to 6, short between the receiving terminals (Xn) corresponding to the unused safety inputs and the drive terminals (Tn). If they are not shorted, the SG-ONE will not turn ON the safety outputs.

  Note: If both of X0 and X1 are turned ON, the SG-ONE will detect an input monitor error. As a result, the error LED displays “1” and the state changes to the Protection state. Input monitor error detection time is 0.5s. If both of X0 and X1 are turned OFF, no error is detected, however, the safety outputs are turned OFF.

**●External device monitoring inputs: X14 and X15 (T14 and T15)**

X14 and X15 (T14 and T15) function as external device monitoring inputs.

X14 and T14 are used as contact monitors for external devices connected to Y0 and Y1.

X15 and T15 are used as contact monitors for external devices connected to Y2 and Y3.

Safety check signals (pulses signals) are transmitted from the drive terminals (T14, T15) to diagnose external devices and monitor circuits. Safety check signals can not be used as the power for connected devices.

Note: If there are unused safety outputs, short between the external device monitoring terminals (Xn) corresponding to the unused safety outputs and the drive terminals (Tn). If they are not shorted, the SG-ONE detects an input monitoring error. As the result, the error LED displays “1” and the state changes to the Protection state.

**● Start inputs: X16 and X17**

X16 is used in teach mode, and it is used to control the start of the safety outputs as an “auto start”, which does not use the start switch, or “manual start”, which does not detect welding of the start switch.

X17 is used to control the start of the safety outputs as a “control start” which detects welding of the start switch.

In teach mode: When X16 is ON (the ON state of X16 must be longer than 0.1s) the device connected to safety input 2 is in a safe state, function output of self-hold function circuit 1 is turned ON. When X17 changes from OFF→ON→OFF (the ON state of X17 must be kept on from between 0.1s to 5s) while the devices connected to safety input 5 and 6 are in a safe state, functional output of self-hold function 3 is turned ON. As the result of being turned ON the functional outputs self-hold function 1 and 3, the start condition is established.

In auto mode: When X17 changes from OFF→ON→OFF (the ON state of X17 must be on between 0.1s to 5s) the devices connected to safety inputs 3 to 6 are in safe state, functional output of self-hold function 2 and3 are turned ON, and the start condition is established.

**●Safety outputs (with OFF-delay timer): Y0 to Y3**

Y0 to Y3 function as safety outputs with the OFF-delay timer. When the timer is set to “0s” (indication “1”), the safety outputs shut OFF immediately.

Y0 and Y1: Safety output 1

Y2 and Y3: Safety output 2

Although teach mode is selected, the preset OFF-delay timer must be added to the reaction time of the SG-ONE.

**●Safety input monitor outputs: Y4 to Y11**

Y4 toY11 function as status monitoring of safety input devices connected to the SG-ONE.

Y4 is turned ON only in the case of teach mode is selected by mode select input.

Y5 is turned ON while both contacts of the safety device are ON. When 1 or more contacts are OFF, the output is OFF.

Y6 to Y11 are turned ON while both contacts of the safety devices are ON. When both contacts of the safety devices are OFF, the output is OFF.

If input monitor error is detected, pulses (1Hz) are transmitted.

Y4 outputs the status of safety input 1 (X0-T0, X1-T1).

Y5 outputs the status of safety input 2 (X2-T2, X3-T3).

Y6 outputs the status of safety input 3 (X4-T4, X5-T5).

Y7 outputs the status of safety input 4 (X6-T6, X7-T7).

Y10 outputs the status of safety input 5 (X10-T10, X11-T11).

Y11 outputs the status of safety input 6 (X12-T12, X13-T13)

**●Safety output monitoring outputs: Y12 and Y13**

Y12 and Y13 function as monitoring outputs that output the status of the safety outputs. When the safety outputs are OFF, the safety output monitor output is turned OFF immediately, even if OFF-delay timer has been set.

Y12 outputs the status of safety output 1 (Y0 and Y1). This turns ON when Y0 and Y1 are both ON.

Y13 outputs the status of safety output 2 (Y2 and Y3). This turns ON when Y2 and Y3 are both ON.

**●State monitoring outputs: Y14 to Y16**

Y14 to Y16 are monitoring outputs for the internal status of the SG-ONE.

Y14 turns ON when in Initial or Stop state.

Y15 turns ON in Initial, Protection or Configuration state.

Y16 turns ON when in Run state.

Refer to “Chapter 4 BASIC OPERATION”, or “Chapter 6 TROUBLESHOOTING”, for details of each state.

Monitor outputs are not safety outputs. Do not use these to construct a safety system.

**●Solenoid outputs: Y17 and Y20**

Y17 and Y20 are outputs for solenoid control that are used with a safety switch with a lock.

Teach mode: In Run state, when the safety outputs are ON, the solenoid outputs are ON.

Auto mode: In Run state, when the safety outputs are OFF and 1 or more safety inputs are OFF, the solenoid outputs are turned ON. When all safety inputs are ON, the solenoid outputs are turned OFF, although start input is not activated.

Solenoid outputs are not safety outputs. Do not use these to construct a safety system.

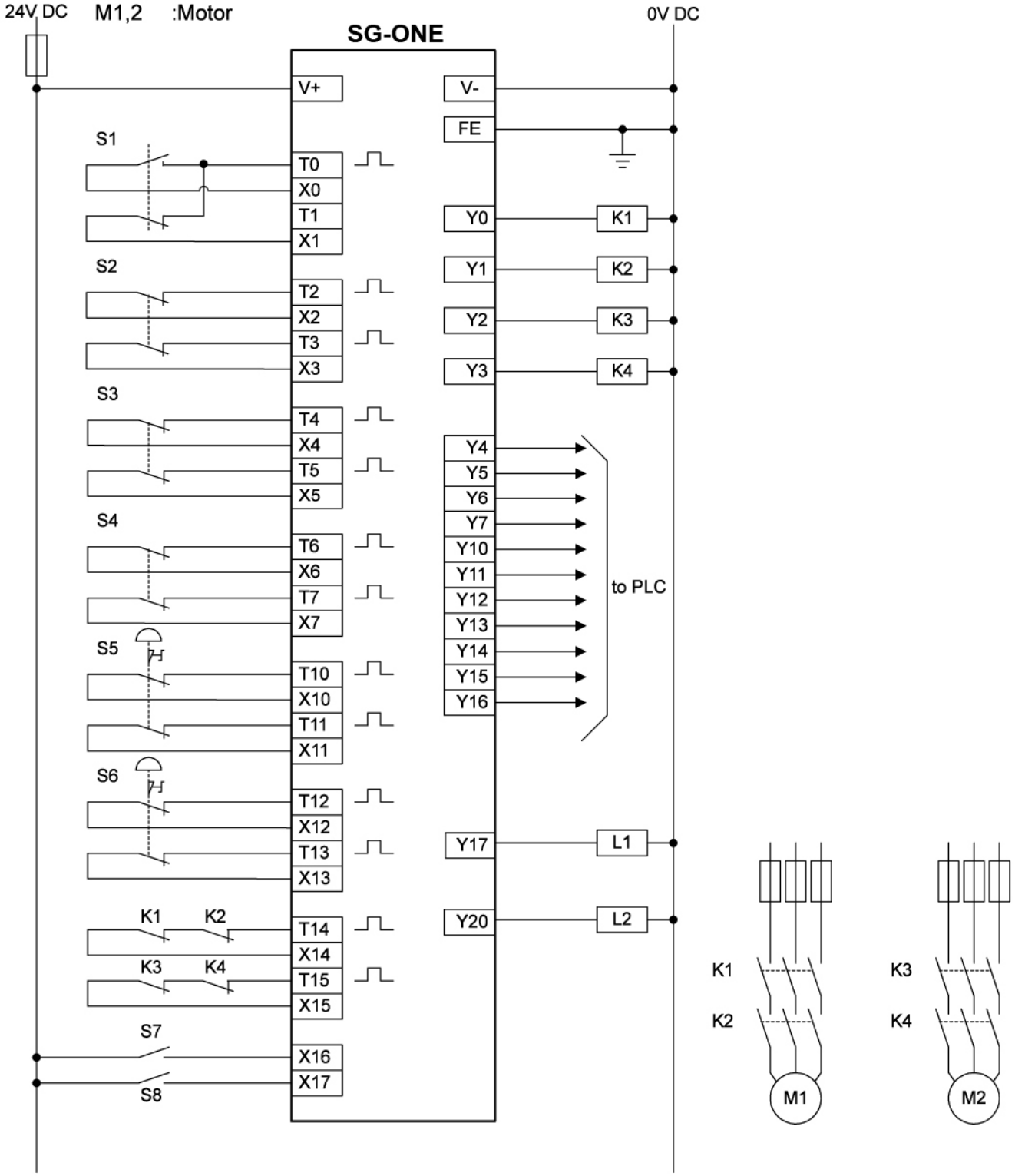
Refer to "Chapter 2 PRODUCT SPECIFICATIONS" for specifications of each input and output.

## Wiring example (Logic 6)

Example of 1 enabling switch, 1 selector switch, 2 emergency stop switches, and 2 safety switches with lock (spring lock type) switches are connected.

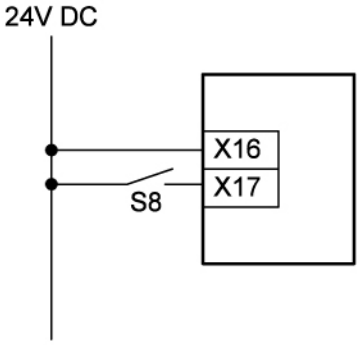
S1 :Selector switch
S2 :Enabling switch
S3,4 :Safety switch with lock (spring lock type)
S5,6 :Emergency stop switch
S7,8 :Start switch
K1...4 :Contactor
L1,2 :Solenoid of safety switch for lock release
M1,2 :Motor

Fuse



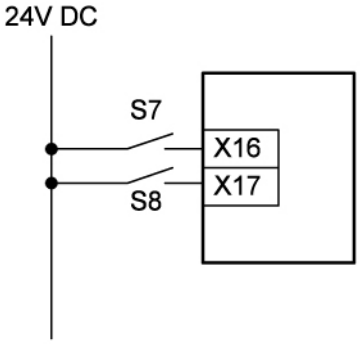
**When not using the start switch in teach mode**

**Auto start**

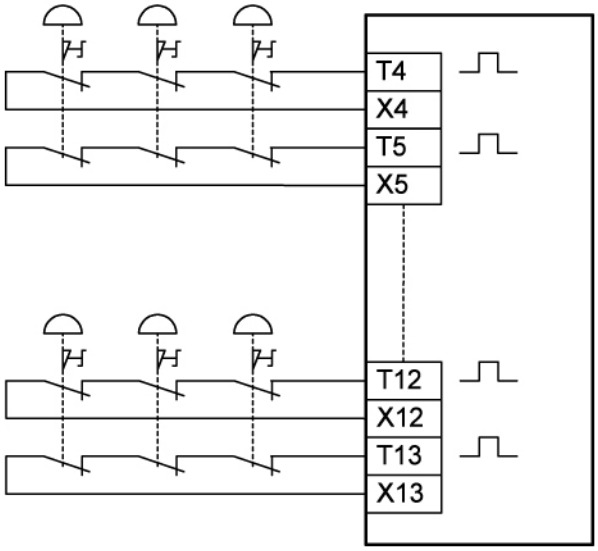



**When detecting the welding of start switch in teach mode**

**Manual start**

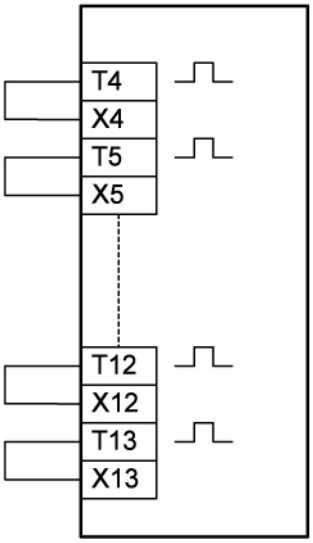



**When connecting multiple emergency stop switches in series**




NOTE:νApplicable safety performance is dependent upon system configuration.

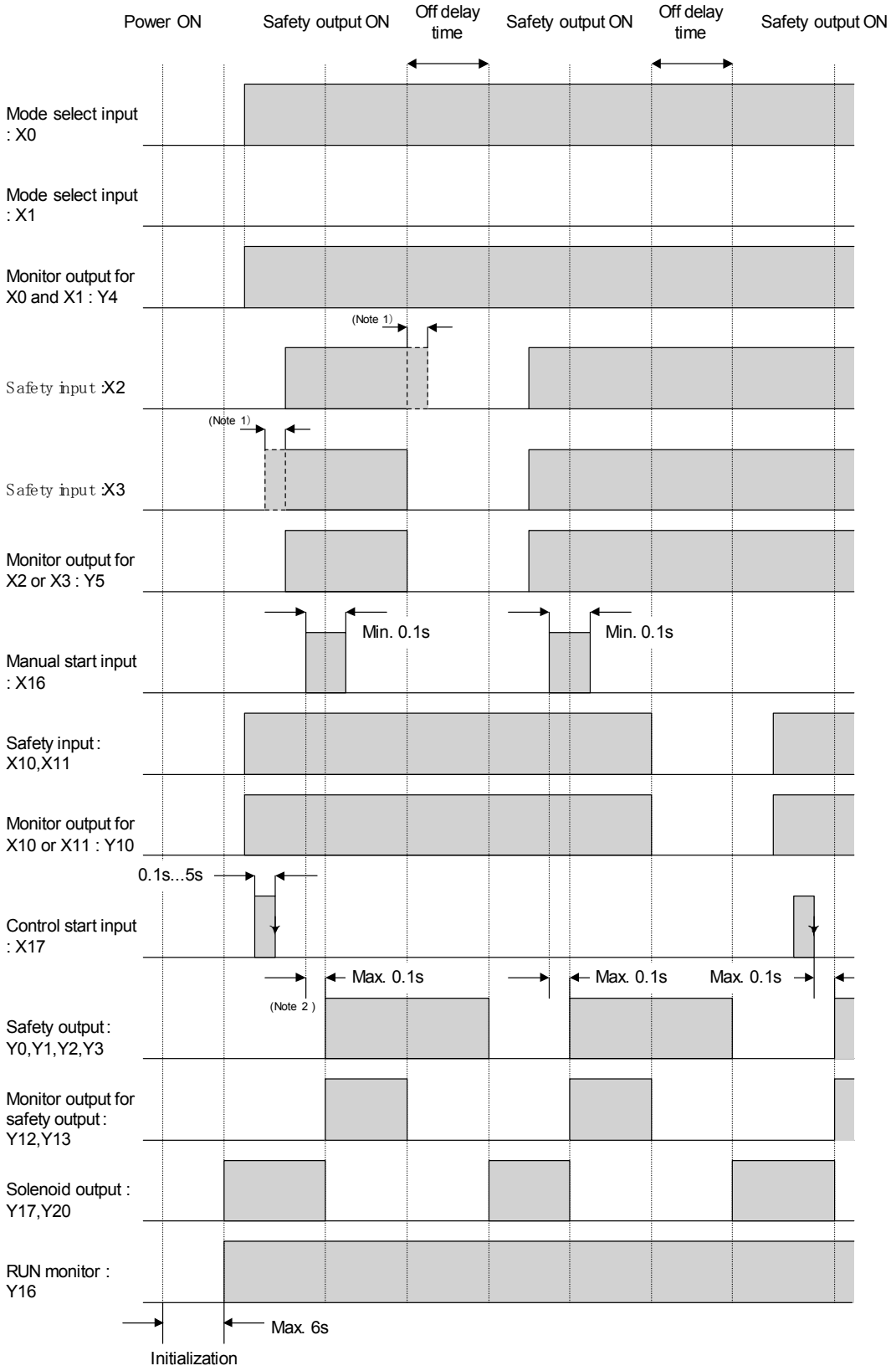
**When not using some safety inputs**




Note: When using a spring lock type safety switch for the safety input of SG-ONE, if the solenoid output of SG-ONE is connected to the solenoid power terminal of the safety switch directly, the start condition cannot be established since the safety input remains in the OFF state. In this case, connect the switch or other equipment to the solenoid output of SG-ONE, and perform the OFF operation of solenoid for lock control.

## Timing chart (Logic 6)

**Teach mode**

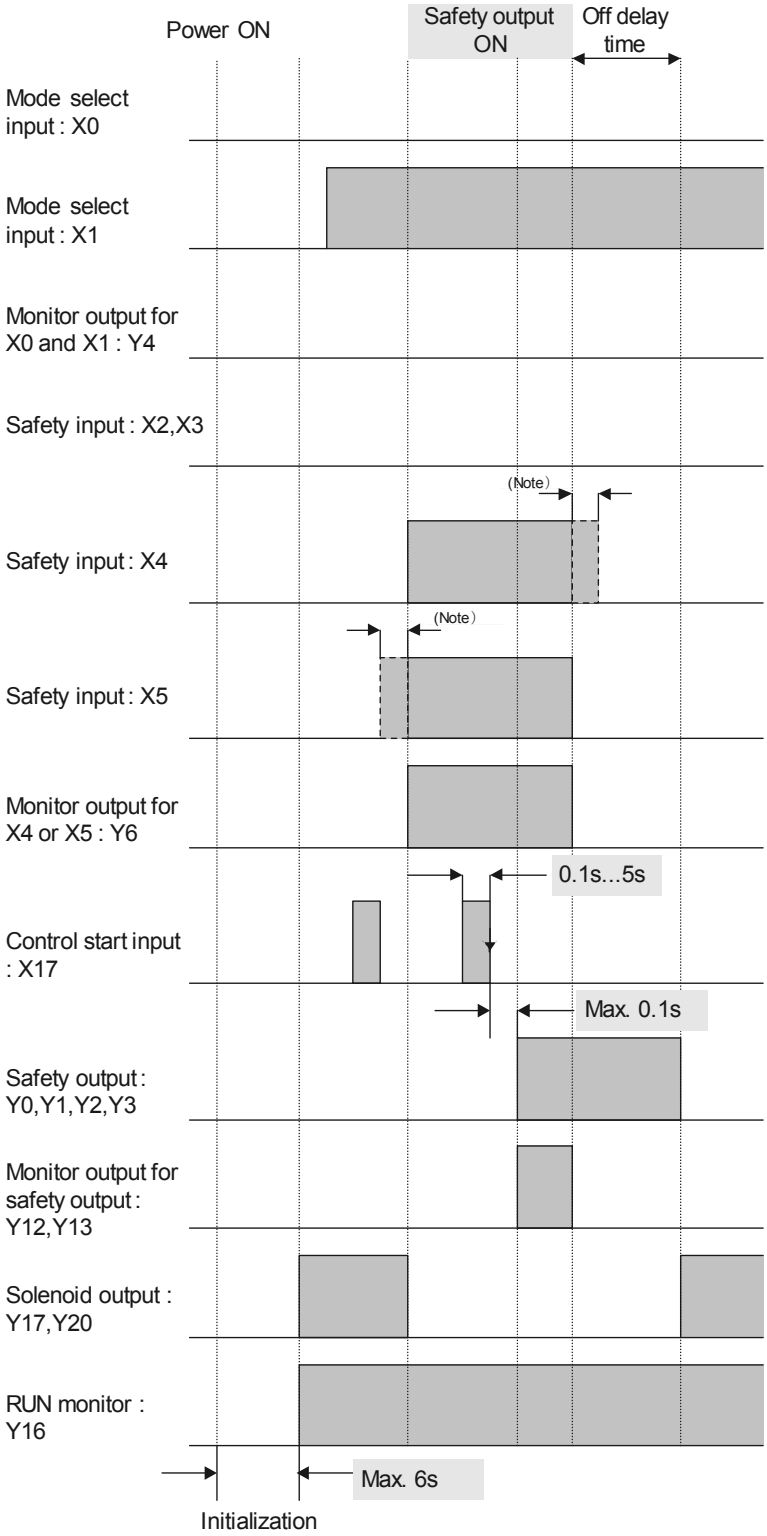



(X4...X7, X12, X13 are ON in this chart.)

Note 1: The input monitor error detection time is infinite in the dual channel dependent inputs (X2-X3).
When the input time difference at the dual channel direct opening inputs (X4-X5, X6-X7, X10-X11, and X12-X13)is 0.5s or more, an input monitor error is detected.
Refer to the following “Logic function” for details.

Note 2: Example to turn on a control start input (X17) before turning on the manual start input (X16).

**Auto mode**




(X6...X13 are ON in this chart.)

Note: When the input time difference of the dual channel safety inputs is 0.5s or more, an input monitor error is detected. Refer to the following "Logic functions" for details.

## Logic 7: Partial stop 1 logic for various machines

# Overview (Logic 7)

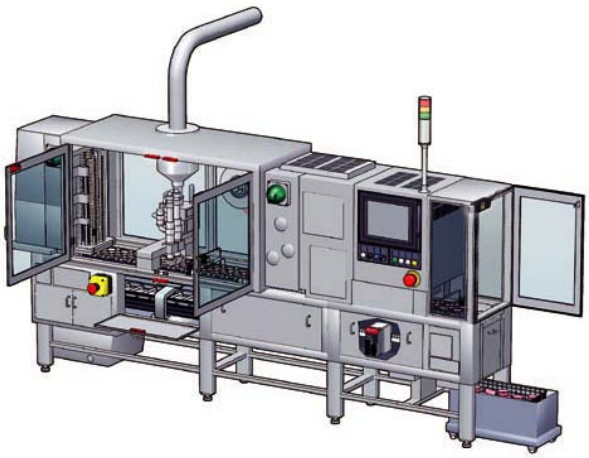
The logic described is for safety protective measures of the equipment which has 2 separate devices that are stopped by safety outputs independently, such as semiconductor manufacturing machines, and food packaging machinery. When the 2 devices can not be stopped at the same time or it is not necessary, the 2 safety outputs can be controlled separately. This logic enables the connection 5 dual channel direct opening inputs.

When in the state in which safety input 1 corresponds to safety output 1 and 2, and safety input 2 and 3 corresponds to safety output 1 can receive safety input signals (the contacts of the connected safety devices are ON), safety output 1 is turned ON upon input of a start input. When in the state in which the safety input corresponds to safety output 1 and 2, and safety input 4 and 5 corresponds to safety output 2 can receive safety input signals, safety output 2 is turned ON upon input of start input.

While safety output 1 and 2 are ON, if an input signal of safety input 1 has been shut OFF (the contact of the safety device is OFF), safety outputs 1 and 2 are turned OFF after a preset OFF-delay time.

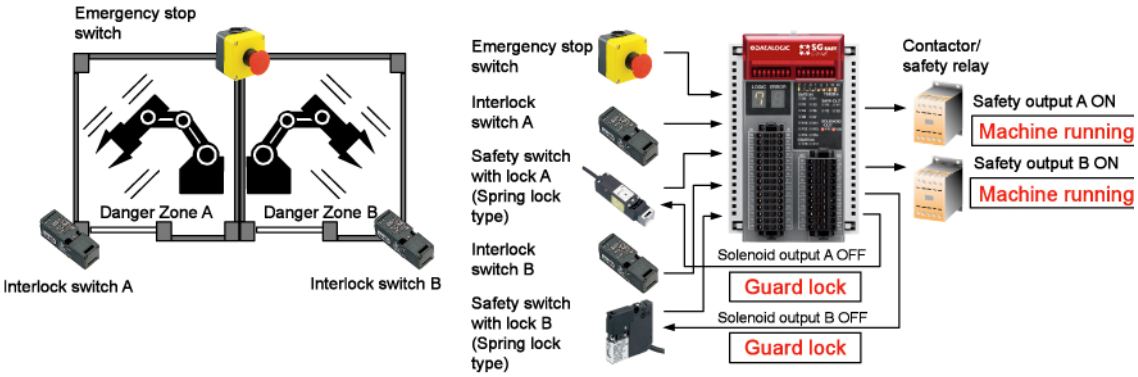
If a safety input signal to safety inputs 2 or 3 is turned OFF, then safety output 1 is turned OFF. If the safety input signal to safety input 4 or 5 is turned OFF, then safety output 2 is turned OFF.

Note: Refer to "Logic circuit" for the details of safety inputs 1, 2, 3, 4, 5 and safety output 1, 2.



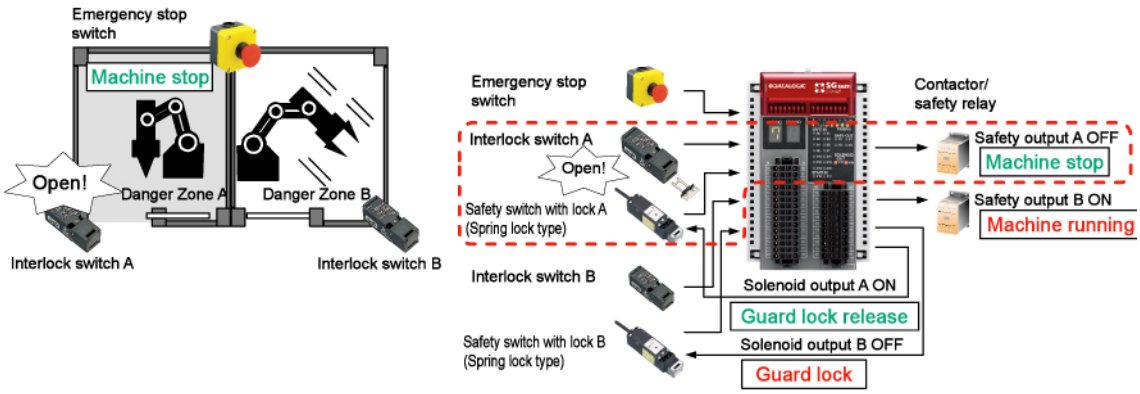
## Operation example (Logic 7)

- Machine running



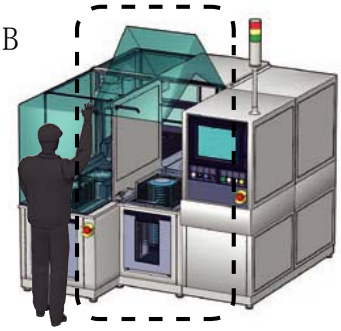

- Machine stop <danger zone A>

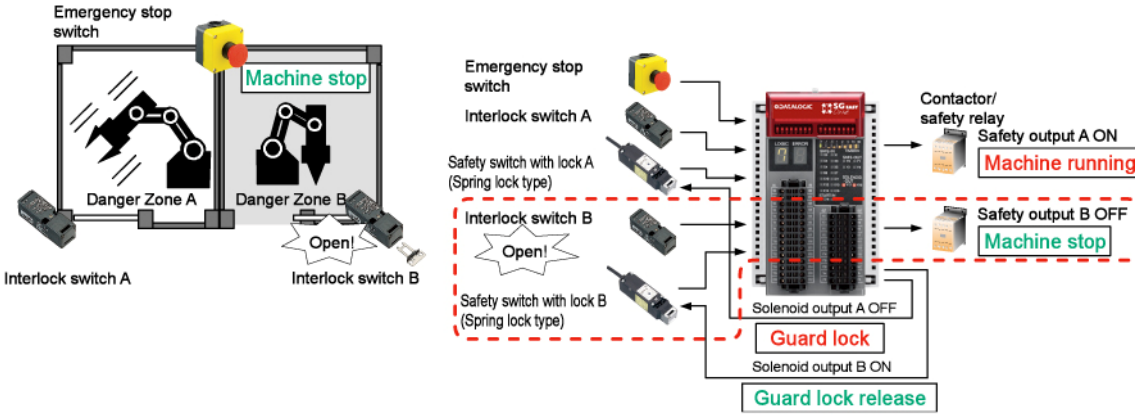
Movable guard A is opened.



- Machine stop <danger zone A>

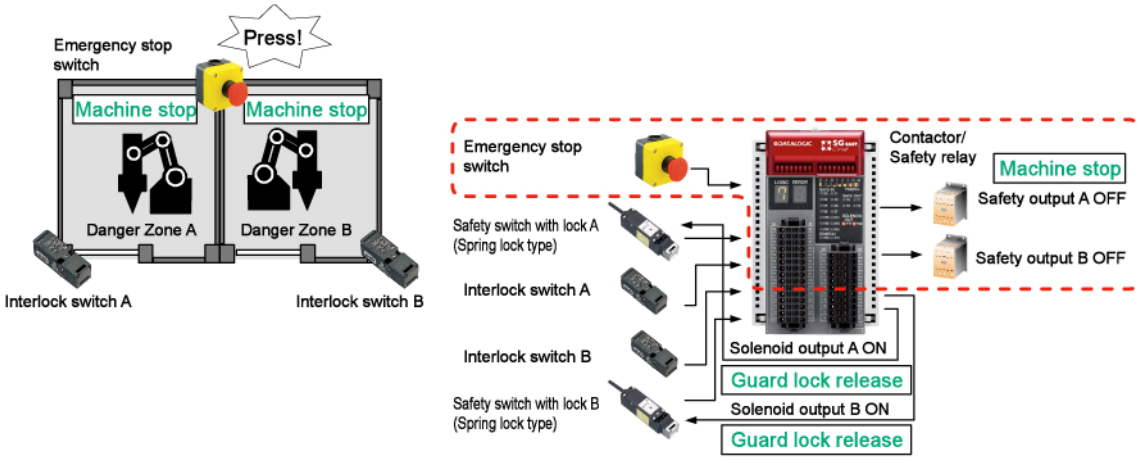
Movable guard B is opened.



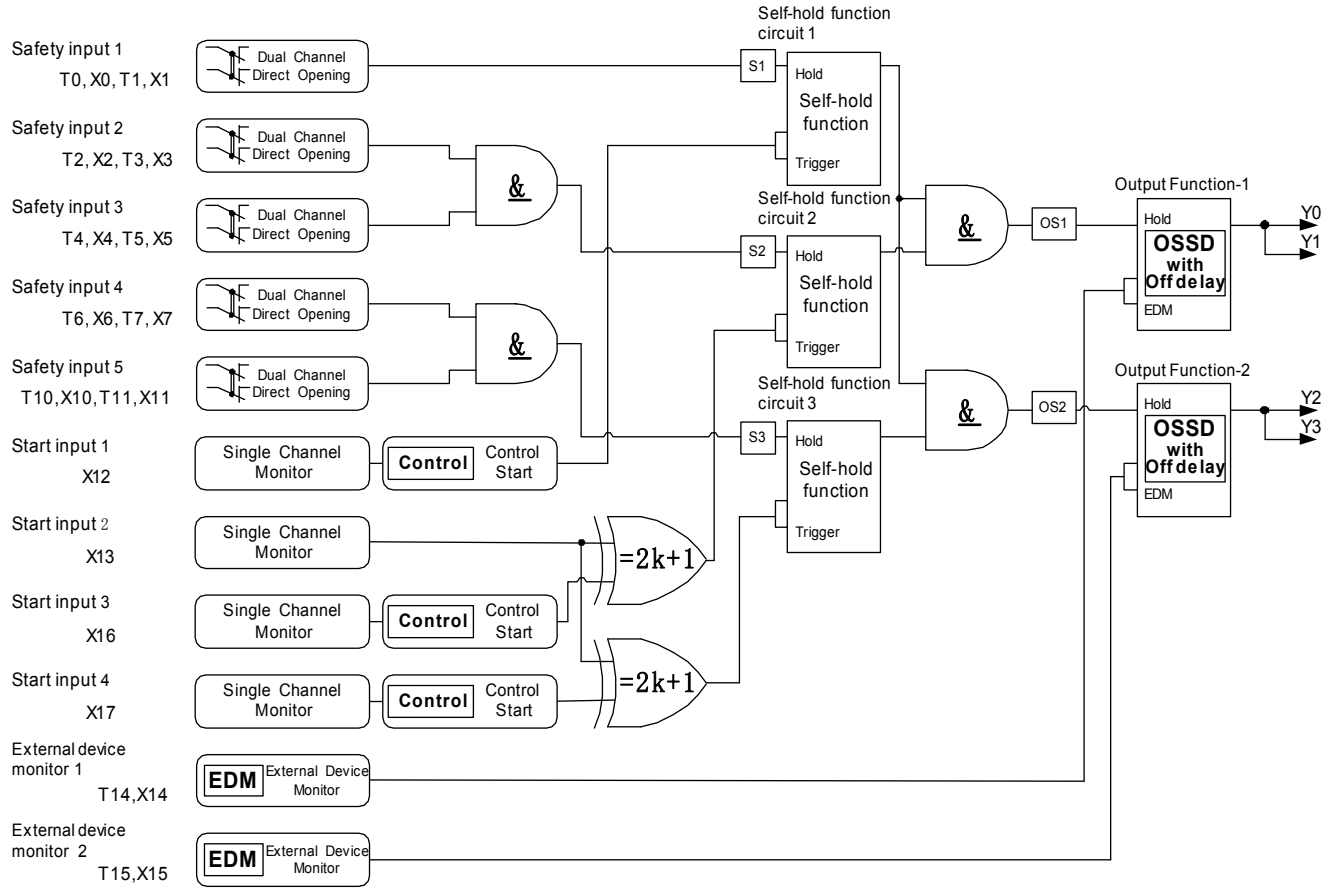



- Whole machine stops <danger zone A・B>

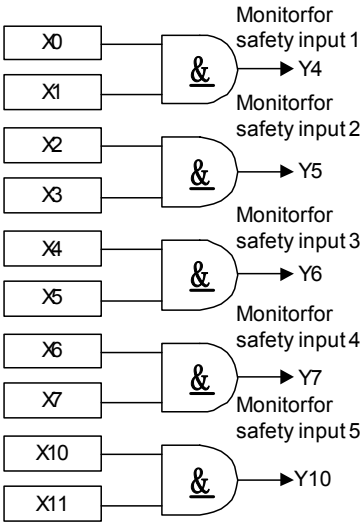
Emergency stop switch is pressed.



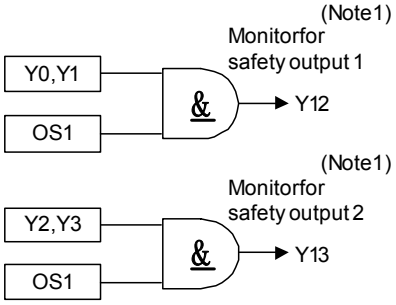
## Logic circuit (Logic7)




●Monitor output for safety input



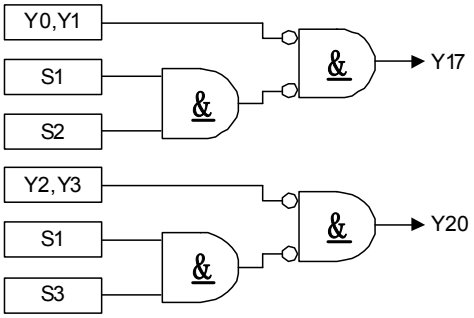

●Monitor output for safety output




Note1:
Monitor outputs for safety output 1 and 2 are turned OFF immediately independent of set OFF-delay time.

●Solenoid output

(Note2)




Note2:
In the Run state, when the safety outputs are OFF and 1 or more corresponding safety inputs are OFF, the solenoid outputs are turned ON. When all corresponded safety inputs are ON, the solenoid outputs are turned OFF without the ON signal of the start input.

## Functions (Logic 7)

**●Safety inputs: X0 to X11 (T0 to T11)**

X0 to X11 (T0 to T11) function as dual channel direct opening inputs.
The combinations of dual channel inputs are shown below. Incorrect use of these combinations will result in an error. The input monitor error detection time between dual channel inputs is 0.5s.
For information about connected control devices, see “SAFETY PRECAUTIONS”.

X0-T0, X1-T1: Safety input 1 (Corresponds to for safety output 1 and 2.)
X2-T2, X3-T3: Safety input 2 (Corresponds to for safety output 1.)
X4-T4, X5-T5: Safety input 3 (Corresponds to for safety output 1.)
X6-T6, X7-T7: Safety input 4 (Corresponds to for safety output 2.)
X10-T10, X11-T11: Safety input 5 (Corresponds to for safety output 2.)

**Warning**

Safety check signals (pulses signals) are transmitted from the drive terminals (T0 to T11) to diagnose connected safety devices and input circuits. Safety check signals can not be used as power for connected devices.

Note: Solid state outputs, such as light curtains, can not be connected.

Note: If there are unused safety inputs, short between the receiving terminals (Xn) corresponding to the unused safety inputs and the drive terminals (Tn). If they are not shorted, the SG-ONE will not turn ON safety outputs.

**●External device monitor inputs: X14 and X15 (T14 and T15)**

X14 and X15 (T14 and T15) function as external device monitoring inputs.
X14 and T14 are used as contact monitoring for external devices connected to Y0 and Y1.
X15 and T15 are used as contact monitoring for external devices connected to Y2 and Y3.

**Warning**

Safety check signals (pulses signals) are transmitted from the drive terminals (T14,T15) to diagnose external devices and the monitor circuits. The safety check signal can not be used as a power for connected devices.

Note: If there are unused safety outputs, short between the external device monitoring terminals (Xn) corresponding to the unused safety outputs and the drive terminals (Tn). If they are not shorted, the SG-ONE detects an input monitoring error. As the result, the error LED displays “1” and the state changes to the Protection state.

● **Start inputs: X12, X13, X16, and X17**

X12 is used to control the start of safety output 1 and 2 as a “control start” which detects welding of the start switch. X12 is the start input for safety input 1.

X13 is used to control the start of safety output 1 and 2 as an “auto start” which does not use a start switch, or a “manual start” which does not detect welding of the start switch. X13 is the start input for safety inputs 2, 3, 4, and 5. X13 is used for a partial stop function.

X16 is used to control the start of safety output 1 as a “control start” which detects welding of the start switch. X16 is the start input for safety inputs 2 and 3. X16 is a partial stop function.

X17 is used to control the start of safety output 2 as a “control start” which detects welding of the start switch. X17 is the start input for safety inputs 4 and 5. X17 is used for a partial stop function.

When X12 changes from OFF→ON→OFF (the ON state of X12 must be on between 0.1s to 5s) while the devices connected to the safety input 1 are in the safe state, and the functional output of self-hold function 1 is turned ON.

When X13 is ON (the ON state of X13 must be on greater than 0.1s) or X16 changes from OFF→ON→OFF (the ON state of X16 must be on between 0.1s to 5s) the devices connected to safety inputs 2 and 3 are in the safe state, the functional output of self-hold function 2 is turned ON.

When X13 is ON (the ON state of X13 must be on greater than 0.1s) or X17 changes from OFF→ON→OFF (the ON state of X17 must be on between 0.1s to 5s) the devices connected to safety inputs 4 and 5 are in the safe state, and the functional output of self-hold function 3 is turned ON.

When the functional output of self-hold functions 1 and 2 are ON, the start condition of safety output 1 is established.

When the functional output of self-hold functions 1 and 3 are ON, the start condition of safety output 2 is established.

Note: If both X13 and X16, or X13 and X17 are turned ON at the same time, an error is detected. As the result, the error LED displays “3” and the state changes to the Stop state. Use only 1 of X13 or X16(X17), but not both at the same time.

Note: Do not use T12 and T13.

●**Safety outputs (with OFF-delay timer): Y0 to Y3**

Y0 to Y3 function as safety outputs with the OFF-delay timer. When the timer is set to “0s” (indication “1”), the safety outputs are shut OFF immediately.

Y0 and Y1: Safety output 1

Y2 and Y3: Safety output 2

**Warning**

When 1 contact of a dual channel input corresponding to only safety output 1 (namely, safety inputs 2 or 3) is turned OFF, safety output 1 is turned OFF immediately after the preset time of the OFF-delay timer, while safety output 2 is turned OFF after the preset time of OFF-delay timer from the input monitoring error detection time (0.5s).

When 1 contact of the dual channel input corresponding to only safety output 2 (namely, safety inputs 4 or 5) is turned OFF, safety output 2 is turned OFF immediately after the preset time of the OFF-delay timer, while safety output 1 is turned OFF after the preset time of OFF-delay timer from input monitoring error detection time (0.5s).

**●Safety input monitoring outputs: Y4 to Y10**

Y4 toY10 function as status monitoring of safety input devices connected to the SG-ONE.

When both contacts of the safety device are ON, the output is ON. When the both contacts are OFF, the output is OFF.

If an input monitoring error is detected, a pulse (1Hz) is transmitted.

Y4 outputs the status of safety input 1 (X0-T0, X1-T1).

Y5 outputs the status of safety input 2 (X2-T2, X3-T3).

Y6 outputs the status of safety input 3 (X4-T4, X5-T5).

Y7 outputs the status of safety input 4 (X6-T6, X7-T7).

Y10 outputs the status of safety input 5 (X10-T10, X11-T11).

**●Safety output monitoring outputs: Y12 and Y13**

Y12 and Y13 function as monitoring outputs that output the status of the safety outputs. When the safety outputs are OFF, the safety output monitor output is turned OFF immediately, even if OFF-delay timer has been set.

Y12 outputs the status of safety output 1 (Y0 and Y1). This turns ON when Y0 and Y1 are both ON.

Y13 outputs the status of safety output 2 (Y2 and Y3). This turns ON when Y2 and Y3 are both ON.

**●State monitoring outputs: Y14 to Y16**

Y14 to Y16 are monitoring outputs for the internal status of the SG-ONE.

Y14 turns ON when in Initial or Stop state.

Y15 turns ON in Initial, Protection or Configuration state.

Y16 turns ON when in Run state.

Refer to “Chapter 4 BASIC OPERATION”, or “Chapter 6 TROUBLESHOOTING”, for details of the each state.

Monitoring outputs are not safety outputs. Do not use these to construct a safety system.

**●Solenoid outputs: Y17 and Y20**

Y17 and Y20 are outputs for solenoid control that are used for safety switch with a solenoid lock.

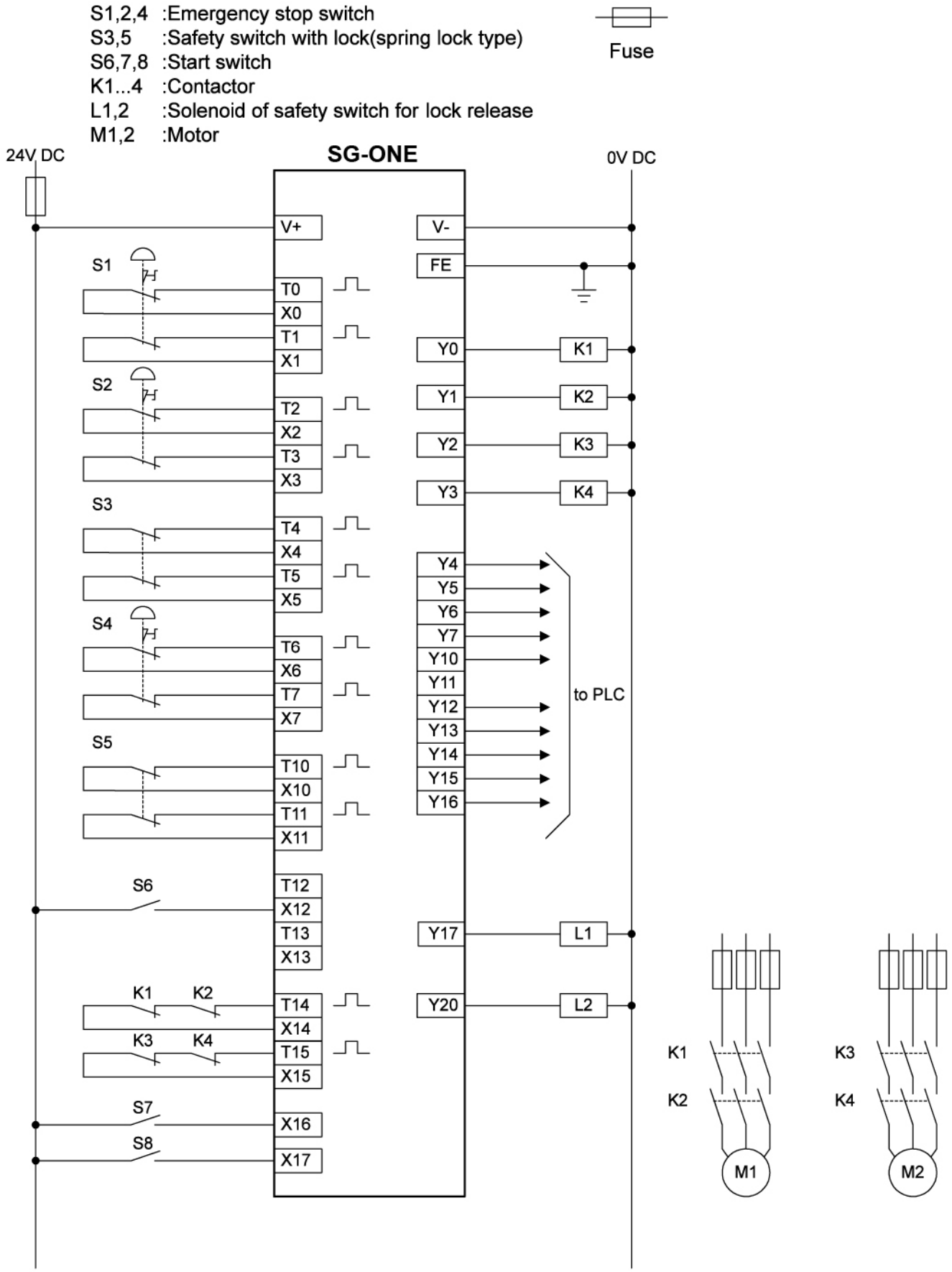
In the Run state, when the safety outputs are OFF and 1 or more safety inputs are OFF, the solenoid outputs are turned ON. When all safety inputs are ON, the solenoid outputs are turned OFF, although the start input is not activated.

Solenoid outputs are not safety outputs. Do not use these to construct a safety system.

Refer to "Chapter 2 PRODUCT SPECIFICATIONS" for specifications of each input and output.

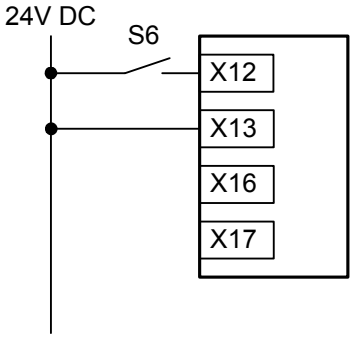
## Wiring example (Logic 7)

An example of 3 emergency stop switches and 2 safety switches with lock safety switches connected.



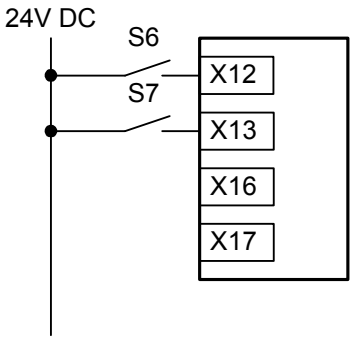
**When not using the start switch for the start input of partial stop**

**Auto start**



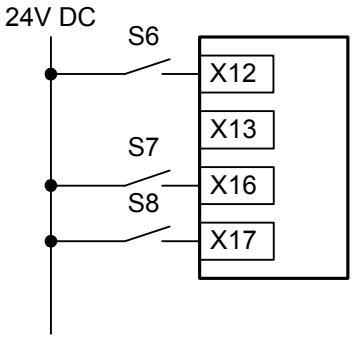

**When not detecting the welding of start switch for partial stop**

**Manual Start**

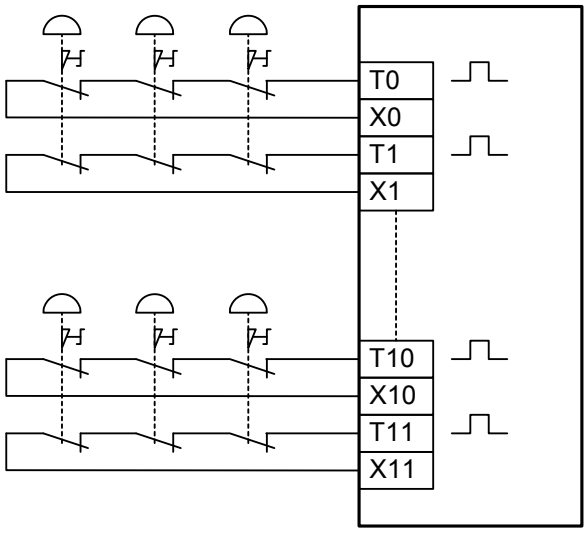



**When detecting the welding of start switch for partial stop**

**Control start**

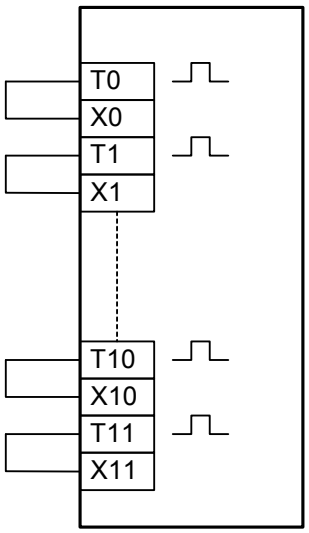



**When connecting multiple emergency stop switches in series**




NOTE: Applicable safety performance is dependent upon system configuration.

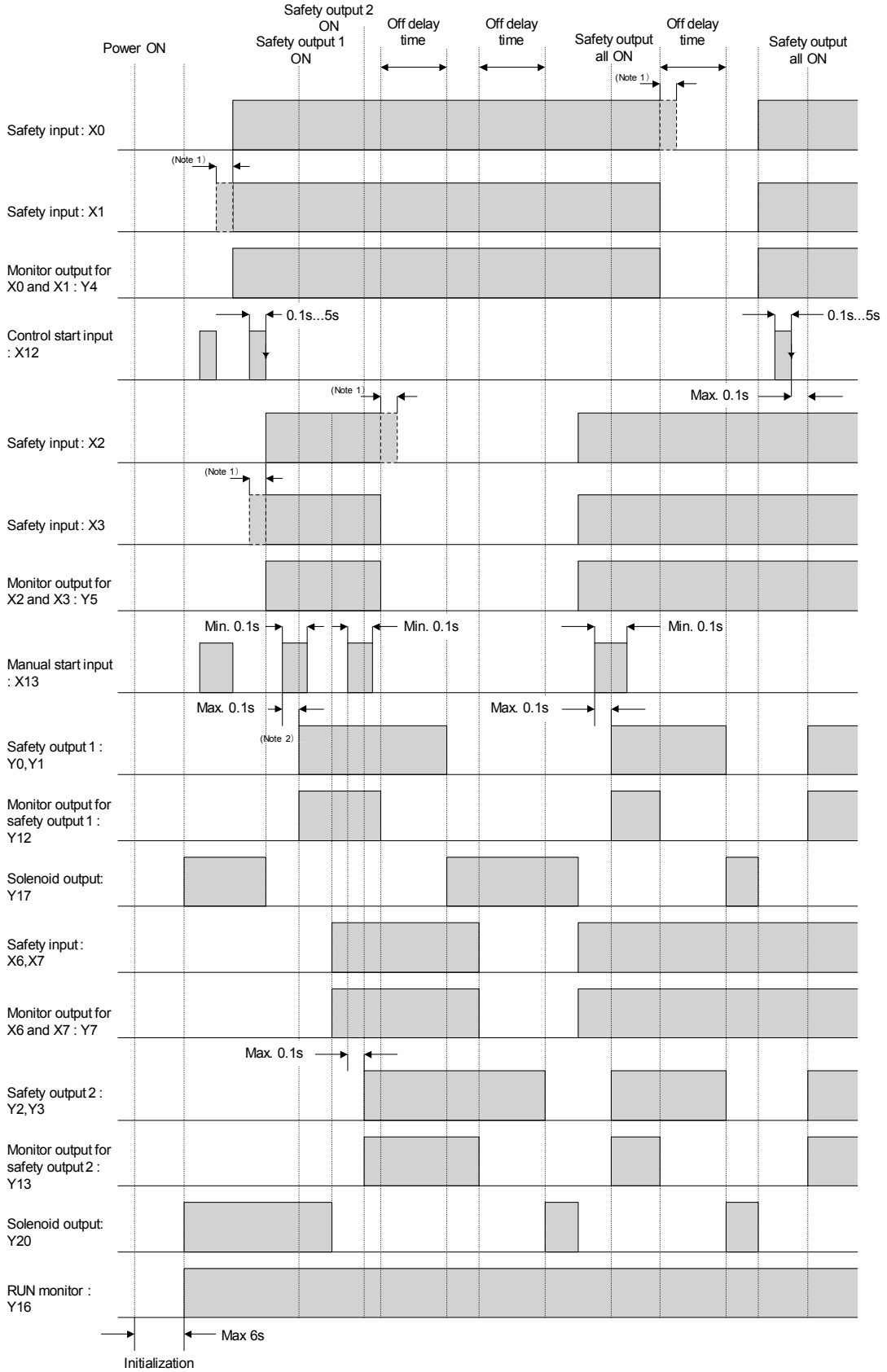
**When not using some safety inputs**




Note: In the case of using a spring lock type safety switch for the safety input of SG-ONE, if the solenoid output of SG-ONE is connected to the solenoid power terminal of the safety swich directly, the start condition cannot be established due to the safety input being in the OFF state. In this case, connect the switch or other equipment to solenoid output of SG-ONE, and perform the OFF operation of solenoid for lock control.

# Timing chart (Logic 7)

**1. Example to use manual start input (X13) which does not detect adhesion of the start switch on partial stop.**

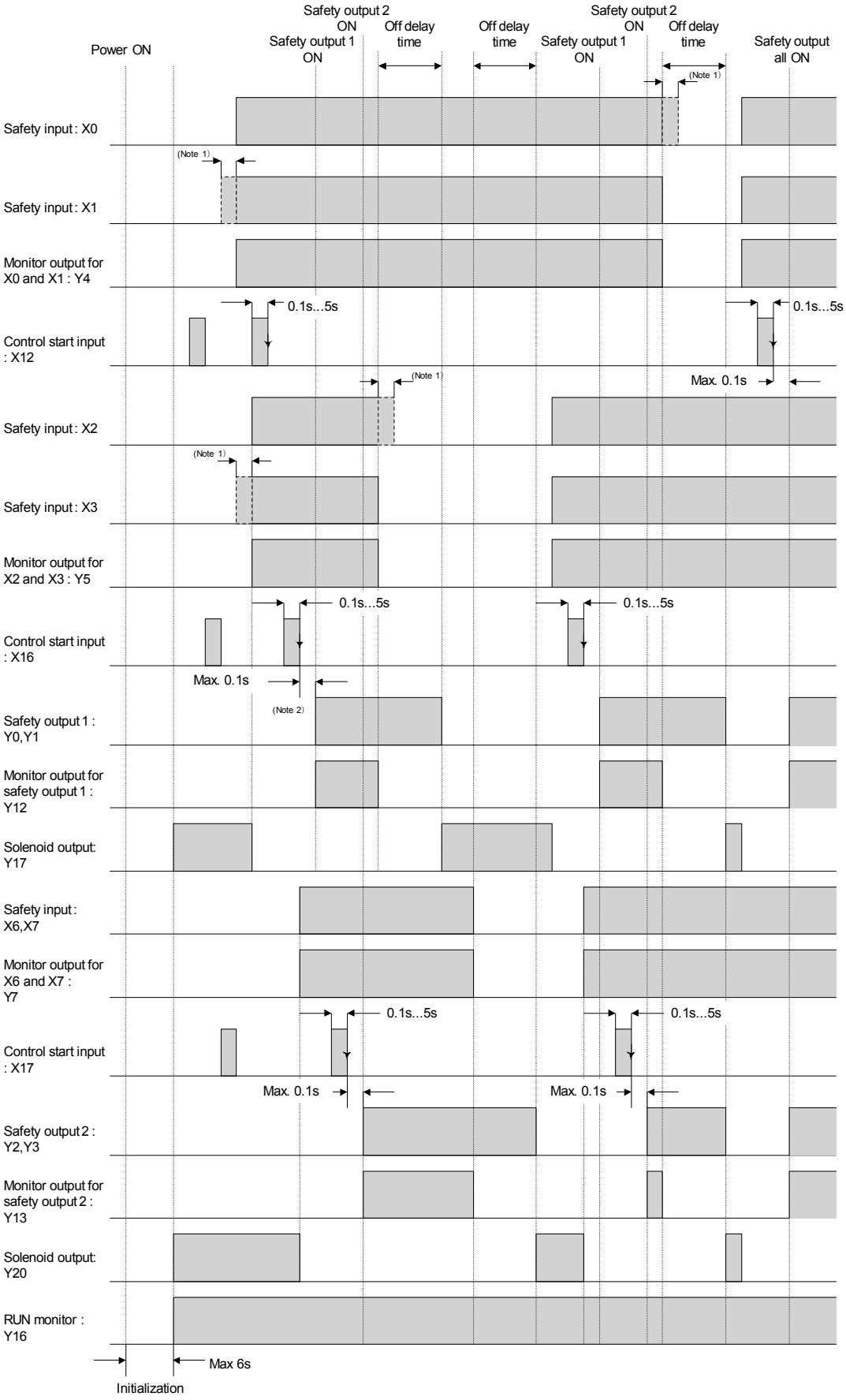



(X4, X5, X10, X11 are ON in this chart.)

Note 1: When the input time difference of the dual channel safety inputs is 0.5s or more, an input monitor error is detected. Refer to the following "Logic functions" for details.

Note 2: Example to turn on the control start input (X12) before turning on the manual start input (X13).

**2. An example to use the control start inputs (X16, X17) that detect adhesion of the start switch on a partial stop.**




(X4, X5, X10, X11 are ON in this chart.)

Note 1: When the input time difference of the dual channel safety inputs is 0.5s or more, an input monitor error is detected. Refer to the following "Logic functions" for details.
Note 2: Example to turn ON control start input (X12) before turning ON control start input (X16).

## Logic 8: Partial stop 2 logic for various machinery

# Overview (Logic 8)

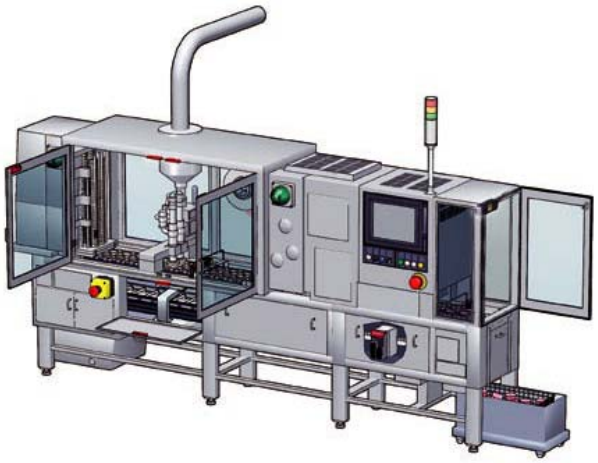
The logic described is for safety protective measures of equipment which has 2 separate devices that are stopped by safety outputs independently, such as semiconductor manufacturing machines, and food packaging machinery. When 2 devices can not be stopped at the same time or it is not necessary, that 2 safety outputs can be controlled separately. This logic enables the connection 5 dual channel direct opening inputs.

When in the state in which safety inputs 1, 2, and 3 correspond to safety outputs 1 and 2 can receive the safety input signals (the contacts of the connected safety devices are ON), the safety output 1 is turned ON upon input of the start input. When in the state in which the all of the safety inputs 1 to 5 can receive safety input signals, safety outputs 1 and 2 are turned ON upon input of the start input.

The safety outputs 1 and 2 are ON, if the input signal to safety inputs 1, 2, or 3 is turned OFF (the contact of the safety device is OFF), safety outputs 1 and 2 are turned OFF after the preset OFF-delay time.

If the safety input signal to safety inputs 4 or 5 corresponding to safety output 2 is turned OFF, safety output 2 is turned OFF.

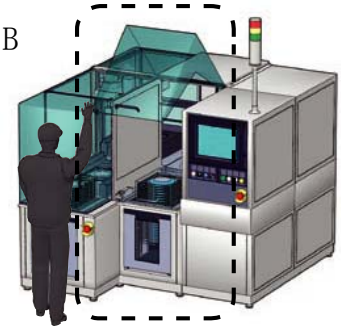
Note: Refer to "Logic circuit" for the details of safety inputs 1, 2, 3, 4, 5 and safety outputs 1, 2.

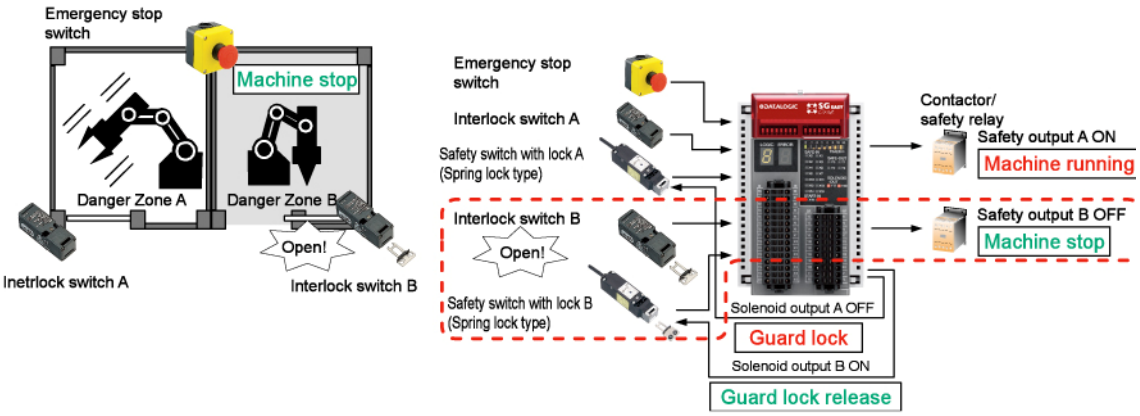


## Operation example (Logic 8)

- ・Machine stop <danger zone B>

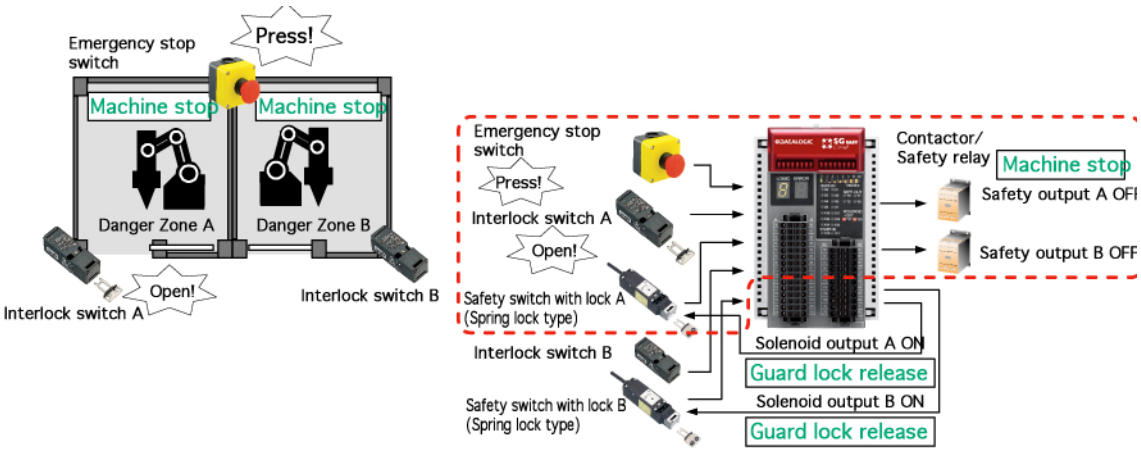
Movable guard B is opened.



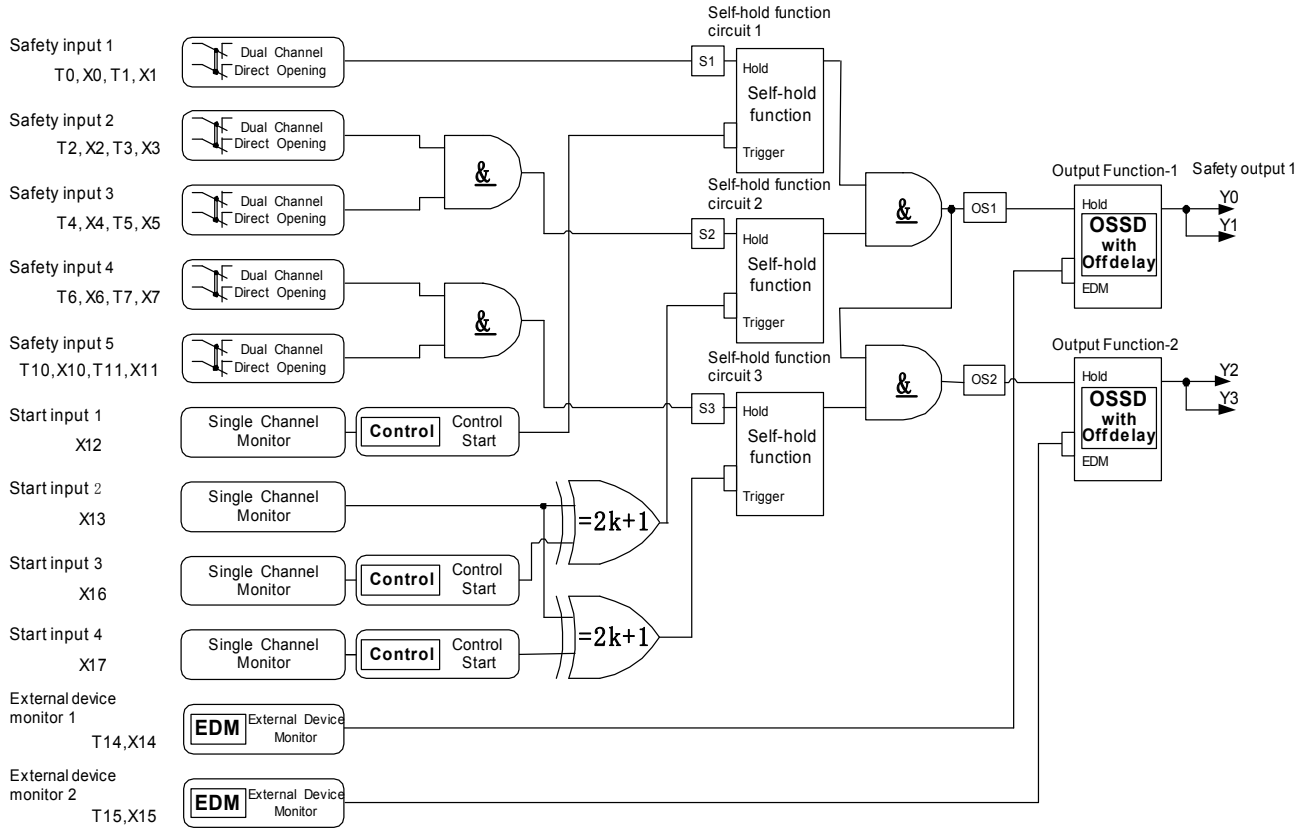



・Machine whole stop <danger zone A・B>

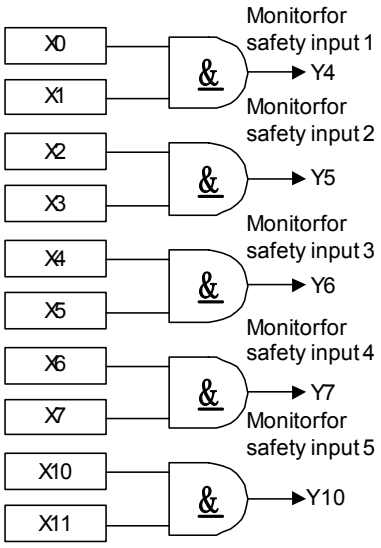
Emergency stop switch is pressed or movable guard A is opened.



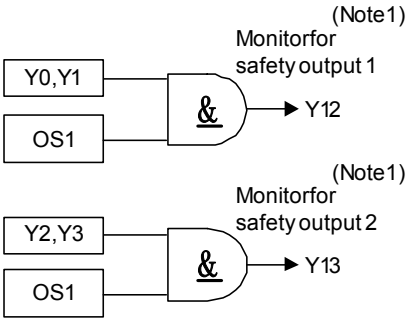
## Logic circuit (Logic 8)




### ●Monitor output for safety input



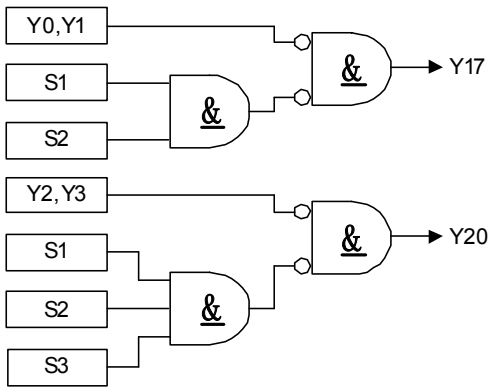

### ●Monitor output for safety output




Note1:
Monitoring outputs for safety output 1 and 2 are turned OFF immediately independent of preset OFF-delay time.

### ●Solenoid output

(Note2)




Note2:
In the Run state, when the safety outputs are OFF and 1 or more corresponding safety inputs are OFF, the solenoid outputs are turned ON. When all corresponding safety inputs are ON, the solenoid outputs are turned OFF without the ON signal of the start input.

## Functions (Logic 8)

**●Safety inputs: X0 to X11 (T0 to T11)**

X0 to X11 (T0 to T11) function as dual channel direct opening inputs.
The combinations of dual channel inputs are shown below. Incorrect use of these combinations will result in an error. The input monitor error detection time between dual channel inputs is 0.5s.
For information about connecting control devices, see “SAFETY PRECAUTIONS”.

X0-T0, X1-T1: Safety input 1 (Corresponding to safety input 1 and 2)
X2-T2, X3-T3: Safety input 2 (Corresponding to safety input 1.and 2)
X4-T4, X5-T5: Safety input 3 (Corresponding to safety input 1 and 2)
X6-T6, X7-T7: Safety input 4 (Corresponding to safety input 2)
X10-T10, X11-T11: Safety input 5 (Corresponding to safety input 2)

**Warning**

Safety check signals (pulses signals) are transmitted from the drive terminals (T0 to T11) to diagnose connected safety devices and input circuits. Safety check signals can not be used as power for connected devices.

Note: Solid state outputs, such as light curtains, can not be connected.

Note: If there are unused safety inputs, short between the receive terminals (Xn) corresponding to the unused safety inputs and the drive terminals (Tn). If they are not shorted, the SG-ONE will not turn ON the safety outputs.

**●External device monitor inputs: X14 and X15 (T14 and T15)**

X14 and X15 (T14 and T15) function as external device monitoring inputs.
X14 and T14 are used as contact monitoring for external devices connected to Y0 and Y1.
X15 and T15 are used as contact monitoring for external devices connected to Y2 and Y3.

**Warning**

Safety check signals (pulses signals) are outputs from the drive terminals (T14, T15) to diagnose external devices and monitoring circuits. The safety check signal can not be used as power for connected devices.

Note: If there are unused safety outputs, short between the external device monitoring terminals (Xn) corresponding to the unused safety outputs and the drive terminals (Tn). If they are not shorted, the SG-ONE detects an input monitoring error. As the result, the error LED displays “1” and the state changes to the Protection state.

● **Start inputs: X12, X13, X16, and X17**

X12 is used to control the start of safety outputs 1 and 2 as a “control start” that detects welding of the start switch. X12 is a start input for safety input 1.

X13 is used to control the start of safety outputs 1 and 2 as an “auto start” which does not use the start switch, or a “manual start” which does not detect welding of the start switch. X13 is a start input for safety inputs 2, 3, 4, and 5. X13 is used for a partial stop function.

X16 is used to control the start of safety outputs 1and 2 as a “control start” that detects welding of the start switch. X16 is a start input for safety inputs 2 and 3. X16 is a partial stop function.

X17 is used to control the start of safety output 2 as a “control start” that detects welding of the start switch. X17 is a start input for safety inputs 4 and 5. X17 is used for a partial stop function.

When X12 changes from OFF→ON→OFF (the ON state of X12 must be on between 0.1s to 5s) while the devices connected to safety input 1 are in the safe state, the function output of the self-hold function 1 is turned ON.

When X13 is ON (the ON state of X13 must be on greater than 0.1s) or X16 changes from OFF→ON→OFF (the ON state of X16 must be on between 0.1s to 5s) while the devices connected to safety inputs 2 and 3 are in safe state, the function output of the self-hold function 2 is turned ON.

When X13 is ON (the ON state of X13 must be on greater than 0.1s) or X17 changes from OFF→ON→OFF (the ON state of X17 must be on between 0.1s to 5s) while the devices connected to safety inputs 4 and 5 are in the safe state, the function output of the self-hold function 3 is turned ON.

When the functional output of the self-hold function 1 and 2 are ON, the start condition of the safety output 1 are established.

When the functional output of the self-hold functions 1, 2, and 3 are ON, the start condition of safety output 2 is established.

Note: If both sets of X13 and X16, or X13 and X17 are turned ON at the same time, the SG-ONE will detect an error. As a result, the error LED displays “3” and the state changes to the Stop state. Use only 1 set of X13 or X16(X17) at a time and never use both together.

Note: Do not use T12 and T13.

●**Safety outputs (with OFF-delay timer): Y0 to Y3**

Y0 to Y3 function as safety outputs with the OFF-delay timer. When the timer is set to “0s” (indication “1”), the safety outputs are shut OFF immediately.

Y0 and Y1: Safety output 1

Y2 and Y3: Safety output 2

**Warning**

When 1 contact of the dual channel input corresponding to safety output 2 (safety inputs 4 or 5) is turned OFF, safety output 2 is turned OFF immediately after the preset time of the OFF-delay timer, while safety output 1 is turned OFF after the preset time of OFF-delay timer from the input monitoring error detection time (0.5s).

**●Safety input monitoring outputs: Y4 to Y10**

Y4 toY10 function as status monitoring of safety input devices connected to the SG-ONE.
When the both contacts of the safety device are ON, the output is ON. When the both contacts are OFF, the output is OFF.
If input a monitoring error is detected, a pulse (1Hz) is transmitted.

Y4 outputs the status of safety input 1 (X0-T0, X1-T1).
Y5 outputs the status of safety input 2 (X2-T2, X3-T3).
Y6 outputs the status of safety input 3 (X4-T4, X5-T5).
Y7 outputs the status of safety input 4 (X6-T6, X7-T7).
Y10 outputs the status of safety input 5 (X10-T10, X11-T11).

**●Safety output monitoring outputs: Y12 and Y13**

Y12 and Y13 function as monitoring outputs that output the status of the safety outputs. When the safety outputs are OFF, the safety output monitoring output is turned OFF immediately, even if the OFF-delay timer has been set.
Y12 outputs the status of safety output 1 (Y0 and Y1). This turns ON when Y0 and Y1 are both ON.
Y13 outputs the status of safety output 2 (Y2 and Y3). This turns ON when Y2 and Y3 are both ON.

**●State monitoring outputs: Y14 to Y16**

Y14 to Y16 are monitoring outputs for the internal status of the SG-ONE.
Y14 turns ON when in Initial or Stop state.
Y15 turns ON in Initial, Protection or Configuration state.
Y16 turns ON when in Run state.
Refer to “Chapter 4 BASIC OPERATION”, or “Chapter 6 TROUBLESHOOTING”, for details of each state.

Monitoring outputs are not safety outputs. Do not use these to construct a safety system.

**●Solenoid outputs: Y17 and Y20**

Y17 and Y20 are outputs for solenoid control that are used for a safety switch with a solenoid lock.
In the Run state, when the safety outputs are OFF and 1 or more safety inputs are OFF, the solenoid outputs are turned ON. When all safety inputs are ON, the solenoid outputs are turned OFF, although the start input is not activated.

Solenoid outputs are not safety outputs. Do not use these to construct a safety system.

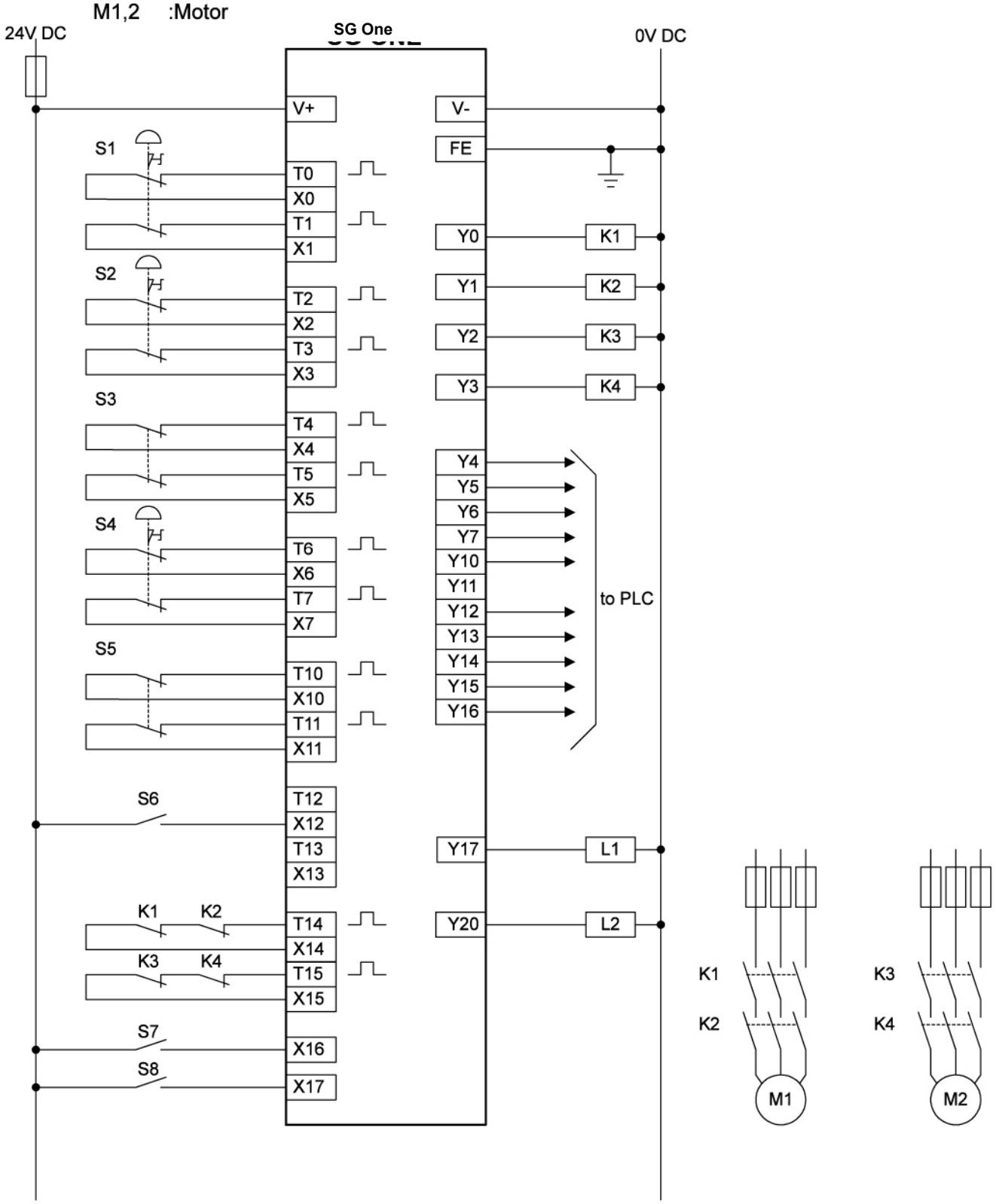
Refer to "Chapter 2 PRODUCT SPECIFICATIONS" for specifications of each input and output.

## Wiring example (Logic 8)

**An example of 3 emergency stop switches and 2 safety switches with lock switches are connected.**

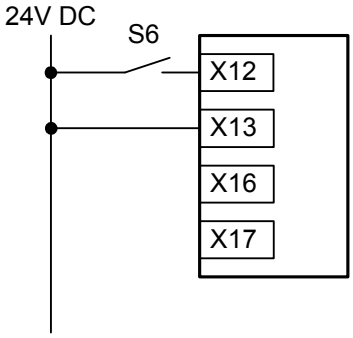
S1,2,4 :Emergency stop switch
S3,5 :Safety switch with lock(spring lock type)
S6,7,8 :Start switch
K1...4 :Contactor
L1,2 :Solenoid of safety switch for lock release
M1,2 :Motor

Fuse



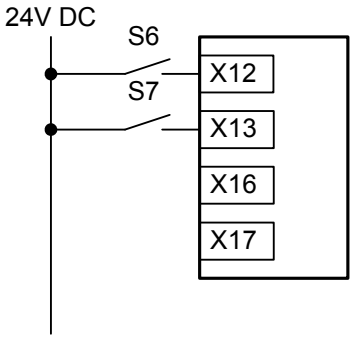
**When not using the start switch for the start input of partial stop**

**Auto start**



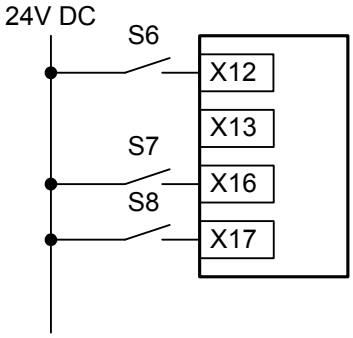

**When not detecting the welding of start switch for partial stop**

**Manual start**

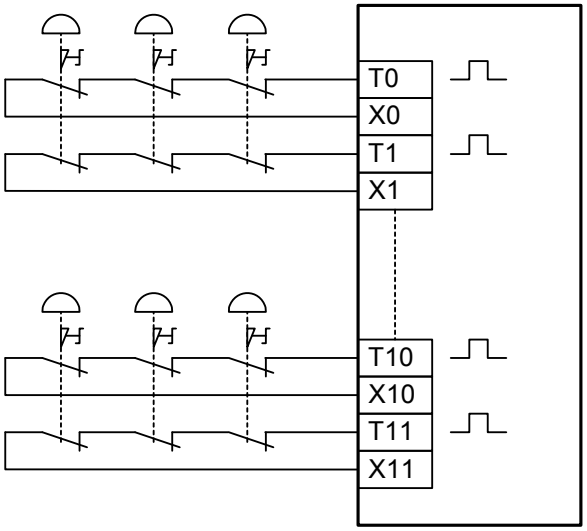



**When detecting the welding of the start switch for partial stop**

**Control start**

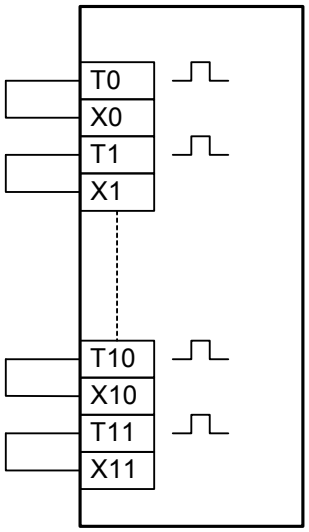



**When connecting multiple emergency stop switches in series**




NOTE: Applicable safety performance is dependent upon system configuration.

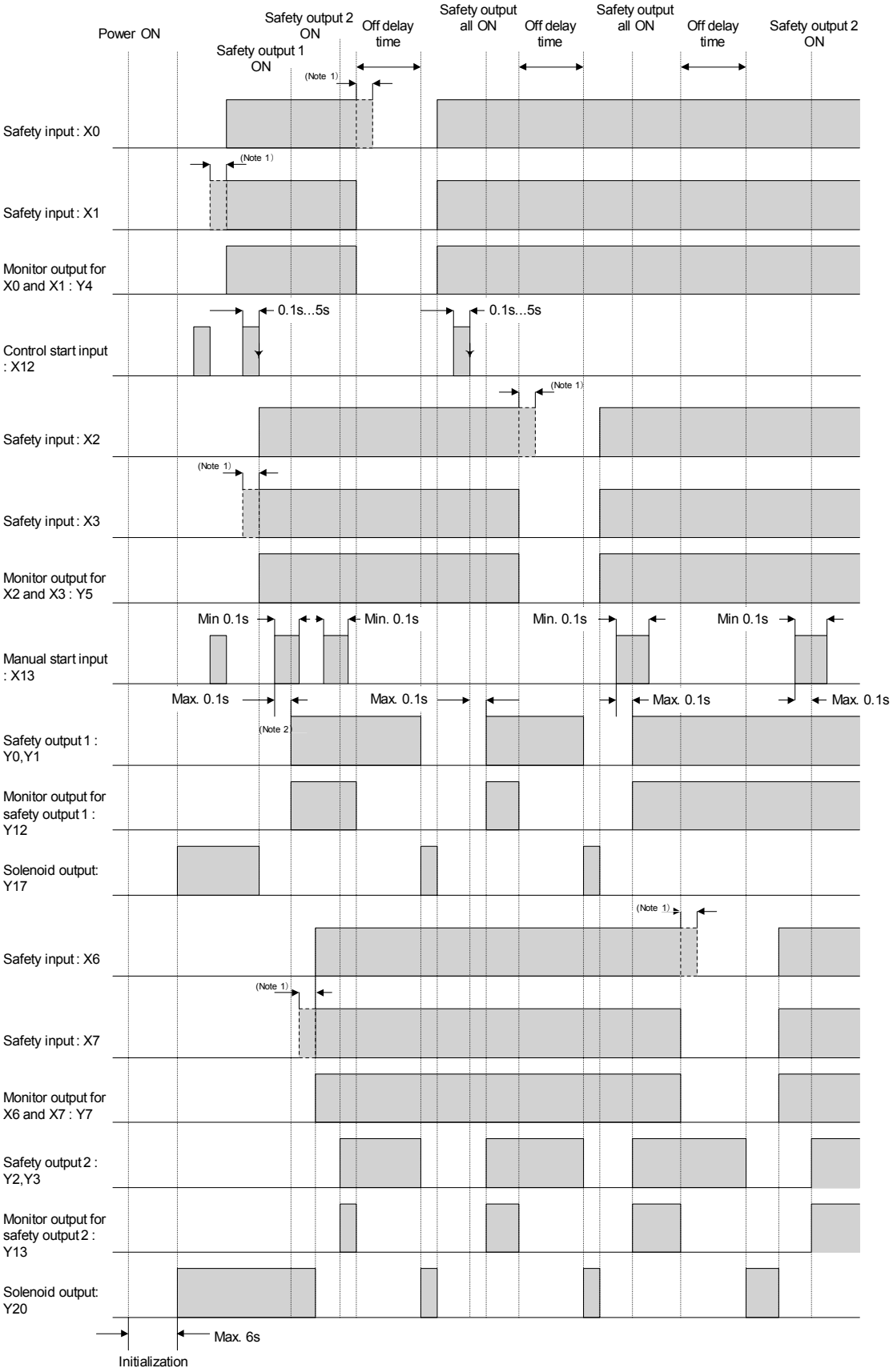
**When not using some safety inputs**




Note: In case of using spring lock type safety switches for safety input of SG-ONE, if the solenoid output of SG-ONE is connected to solenoid power terminal of the safety swich directly, the start condition cannot be established due to the safety input being in the OFF state. In this case, connect the switch or other equipment to the solenoid output of SG-ONE, and perform the OFF operation of solenoid for lock control.

# Timing chart (Logic 8)

**1. Example to use a manual start input (X13) which is not detected adhesion of the start switch on partial stop.**

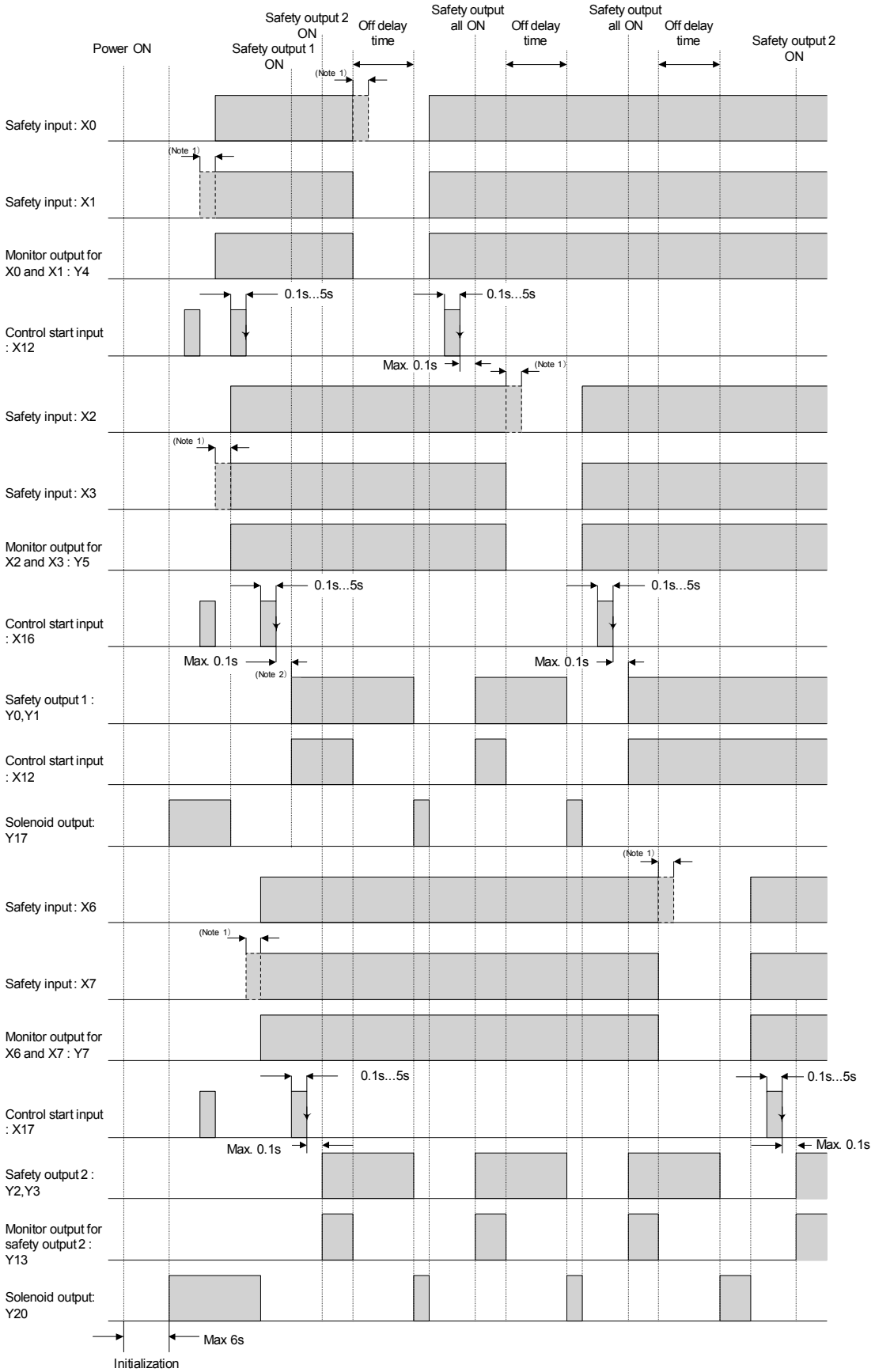



(X4, X5, X10, X11 are ON in this chart.)

Note 1: When the input time difference of the dual channel safety inputs is 0.5s or more, an input monitor error is detected. Refer to the following "Logic functions" for details.

Note 2: Example to turn on a control start input (X12) before turning on a manual start input (X13).

**2. Example of control start inputs (X16, X17) which are detected adhesion of the start switch on a partial stop.**




(X4, X5, X10, X11 are ON in this chart.)

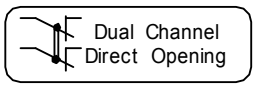
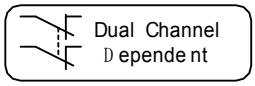
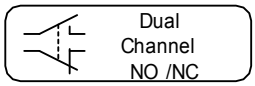
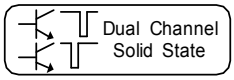
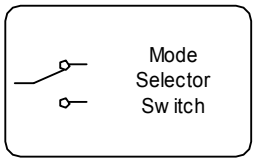
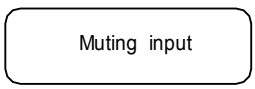
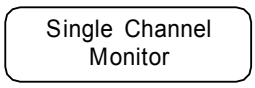
Note 1: When the input time difference of the dual channel safety inputs is 0.5s or more, an input monitor error is detected. Refer to the following "Logic functions" for details.

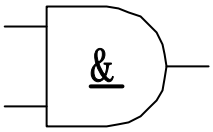
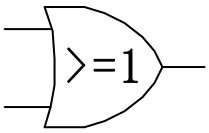
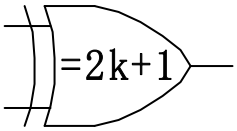
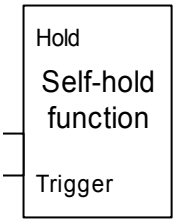
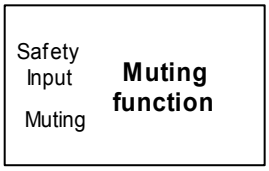
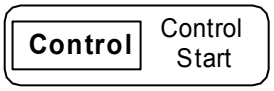
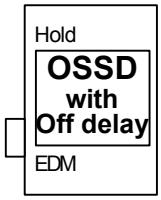
Note 2: Example to turn on a control start input (X12) before turning on a control start input (X16).

## Logic functions

This section describes the functions of each logic circuit. The logic functions are separated into input, logic operation, and output functions in Table 5-1. Select the appropriate logic after understanding its functionality.

Table 5-1 List of logic functions

| Type | Function | Symbol | Description | Reference page |
|---|---|---|---|---|
| Input function | Dual channel direct opening input |  | This function is for connecting safety devices with dual channel direct opening action mechanisms, such as emergency stop interlock switches. | 5-75 |
| | Dual channel dependent input |  | This function is for connecting safety devices with a dual channel dependent action mechanism, such as an enabling switch. | 5-76 |
| | Dual channel NO/NC input |  | This function is for connecting a safety device with a dual channel NO/NC mechanism, such as a non-contact interlock switch. | 5-77 |
| | Dual channel solid state input |  | This function is for connecting safety devices with dual channel solid state outputs (PNP output), such as safety light curtain or safety laser scanner. | 5-79 |
| | Mode select input |  | This function is for connecting devices with a mode selector function, such as mode selector switch. | 5-81 |
| | Muting input |  | This function is for connecting a sensor or other input device to perform muting. | 5-83 |
| | Monitor input |  | This function is for connecting a switch or sensor for use as a start input. | 5-85 |
| | External device monitor input | | This function is for monitoring external devices controlled by the SG-ONE. External devices are diagnosed for errors by connecting a NC contact, such as a contactor or safety relay. | 5-87 |

| Type | Function | Symbol | Description | Reference page |
|---|---|---|---|---|
| Logic operation function | AND function |  | This function means logical (AND) of multiple inputs. | 5-96 |
| | OR function |  | This function means logical (OR) of multiple inputs. | 5-96 |
| | XOR function |  | This function means exclusive logical (XOR) of the multiple inputs. | 5-97 |
| | Self-hold function |  | This function means self-holding of an input. | 5-97 |
| | Muting function |  | This function adds a muting function to the connected safety devices. | 5-98 |
| | Control start |  | This function adds an operation confirmation function to the connected start input devices. | 5-99 |
| Output function | Safety output with timer |  | This function is for controlling the safety output. | 5-100 |

## Dual channel direct opening input

This function is for connecting safety devices with dual channel direct opening action mechanisms, such as an emergency stop switch or an interlock switch. As shown in Fig. 5-1, this function is comprised of a dual channel input receive circuit ($X_n$, $X_{n+1}$), drive circuit ($T_n$, $T_{n+1}$), and function output ($I_n$).

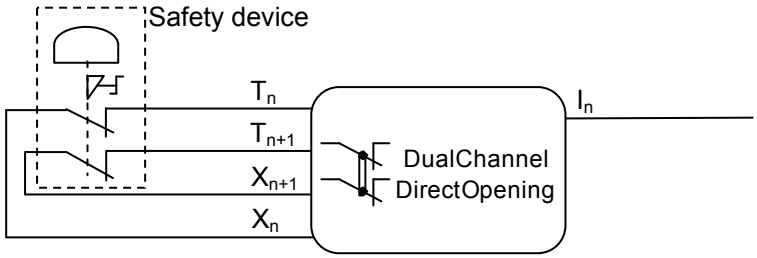



Fig. 5-1 Circuit for dual channel direct opening input functions

### Connects to

Safety devices with direct opening mechanisms, such as an emergency stop switch or an interlock switch.

Note: This cannot be connected to a safety light curtain or other safety solid state outputs.

### Description of operation

The operation timing is described in Fig. 5-2.

I. When safety check signals from the 2 drive circuits are supplied to the 2 receiving circuits, the output is turned ON. (Ex. Emergency stop switch is released, the guard is closed.)

II. When safety check signal to either of the receiving circuits is turned OFF, the output is turned OFF. (Ex. Emergency stop switch is released, the guard is opened.)

III. If safety check signals are not correctly supplied to the receiving circuits, due to the error in the safety device or input circuit, the output is turned OFF immediately. Status of any detected error is reflected by the error LED, input LEDs and monitor output. (Ex. Fault in emergency stop switch or interlock switch, or wiring.)

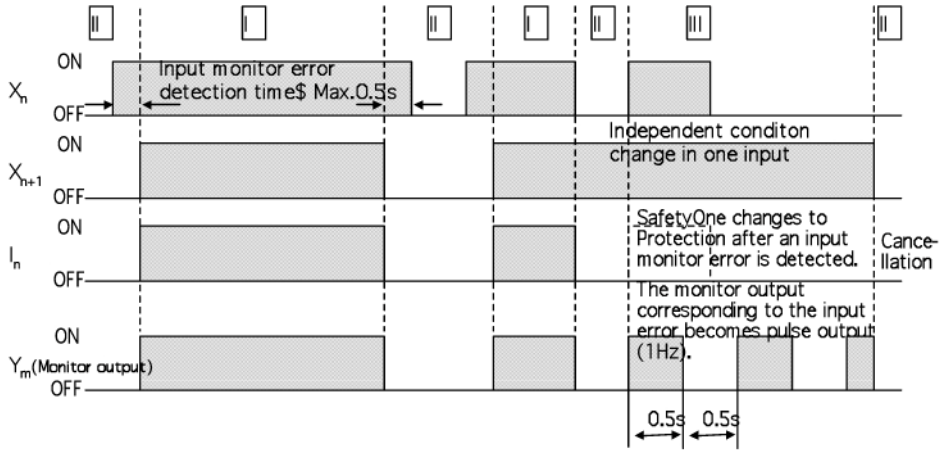



Fig. 5-2 Operation timing of a dual channel direct opening input function

## Error detection function

**Input monitoring**

When an error is detected between dual channel inputs, the SG-ONE changes to the Protection state and displays "1" on the error LED display. The conditions to be detected as input errors are shown below.

(1) When the input monitor error detection time (0.5s) is exceeded during 2 input conditions or do not match (namely ON/OFF or OFF/ON).

(2) When there is an independent condition change at 1 of v the inputs.

The input LEDs blink and the monitor output ($Y_m$) outputs pulses (1Hz), to notify the operator of the corresponding input. See Fig. 5-2.

**Short circuit and grounding detection**

When an input error, such as a short circuit, grounding, or circuit failure, is detected, the SG-ONE changes to the Stop state and displays "2" on the error LED display.

**Noise detection filter**

When the SG-ONE is used in an environment with severe noise, the SG-ONE changes to the Stop state and displays "9" on the error LED display.

**Warning**

Safety check signals (pulses signals) are transmitted from the drive circuits ($T_n$) to diagnose connected safety devices and input circuits. Safety check signals can not be used as power for connected devices.

## Dual channel dependent input

This function is for connecting safety devices with a dual channel dependent action mechanism, such as an enabling switch. As shown in Fig. 5-3, this function is comprised of a dual channel input receive circuit ($X_n$, $X_{n+1}$), a drive circuit ($T_n$, $T_{n+1}$), and a functional output ($I_n$). The difference from dual channel direct opening input, is that the dependency of the 2 inputs is monitored with the dual channel dependent input function, but the dependent time is infinite.

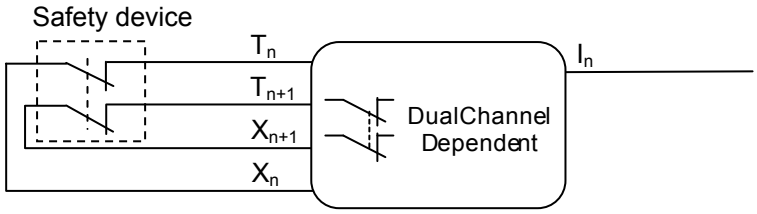



Fig. 5-3 Circuit for dual channel dependent input function

### Connects to

Safety devices with a direct opening mechanism, such as emergency stop switch or an interlock switch.
Safety devices with a contact dependent mechanism, such as an enabling switch.

Note: This cannot be connected to a safety light curtain or any other safety solid state outputs.

### Description of operation

The operation timing is described in Fig. 5-4.

I. When the safety check signals from the 2 drive circuits are correctly supplied to the 2 input receiving circuits, the output is turned ON. (Ex. Guard is closed.)
II. When the safety check signal to either of the receiving circuits is turned OFF, the output is turned OFF. (Ex. Guard is opened.)
III. If safety check signals are not supplied correctly to the receiving circuits, due to an error in the safety device or input circuit, the output is turned OFF immediately. Status of a detected error is displayed by the error LED, input LEDs and monitoring output. (Ex. Fault in Interlock switch or wiring error)

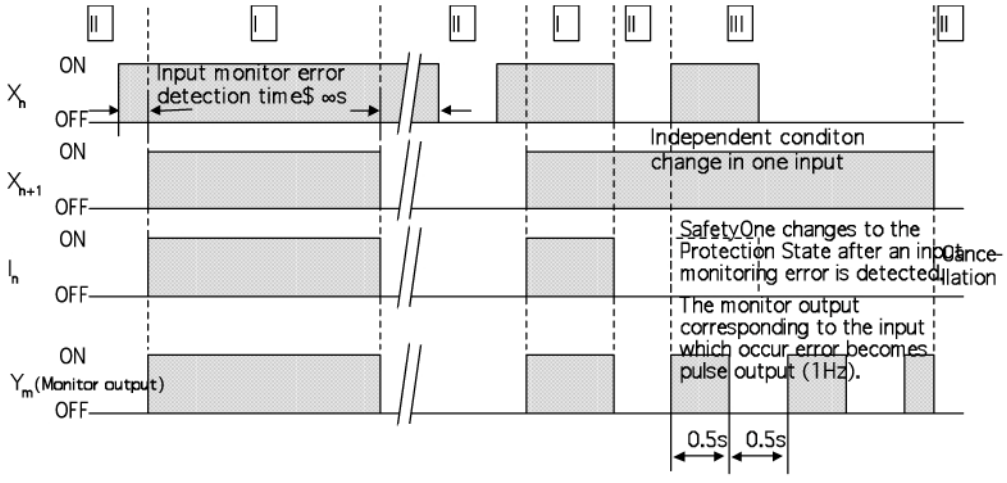



Fig. 5-4 Operation timing of a dual channel dependent input function

## Error detection function

**Input monitoring**

When an error is detected between the dual channel inputs, the SG-ONE changes to the Protection state and displays "1" on the error LED display. The condition to be detected as an input error is shown below.

(2) When there is an independent condition change of 1 of the inputs

The input LEDs blink and the monitoring output ($Y_m$) outputs pulses (1 Hz), to notify the operator of the corresponding input. See Fig. 5-4.

Note: The dependency of the 2 inputs is monitored with the dual channel dependent input function, but the dependent time is infinite.

**Short circuit and grounding detection**

When an input error, such as a short circuit or circuit failure, is detected, the SG-ONE changes to the Stop state and displays "2" on the error LED display.

**Noise detection filter**

When the SG-ONE is used in an environment with severe noise, the SG-ONE changes to the Stop state and displays "9" on the error LED display.

**Warning**

Safety check signals (pulses signals) are supplied from the drive circuits ($T_n$) to diagnose connected safety devices and input circuits. Safety check signals can not be used as power for connected devices.

## Dual channel NO/NC input

This function is for connecting safety devices with dual channel NO/NC mechanisms, such as non-contact interlock switches. As shown in Fig. 5-5, this function is comprised of a dual channel input receiving circuit ($X_n$, $X_{n+1}$), a drive circuit ($T_n$, $T_{n+1}$), and a functional output ($I_n$). Because safety devices comprised of NO and NC contacts are connected, during normal operation, 1 of the dual channel inputs is ON while the other is OFF.

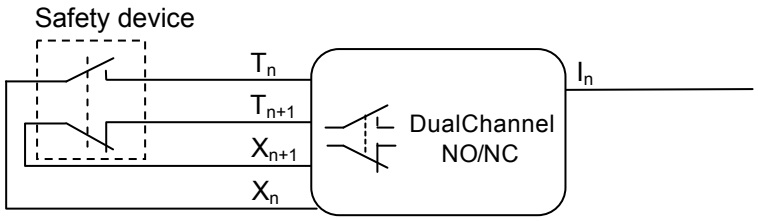



Fig. 5-5 Circuit for dual channel NO/NC input function

### Connects to

Safety devices with NO/NC contacts, such as a non-contact interlock switch.

Note: This cannot be connected to a safety light curtain or any other safety solid state output.

### Description of operation

The operation timing is described in Fig. 5-6.

I. When a safety check signal from 1 of the 2 drive circuits ($T_{n+1}$) is supplied to the corresponding receiving circuit ($X_{n+1}$) and the other receiving circuit ($X_n$) is OFF, the output is turned ON. (Ex. Guard is closed.)

II. When a safety check signal from 1 of the 2 drive circuits ($T_n$) is supplied to the corresponding receiving circuit ($X_n$), and the other receiving circuit ($X_{n+1}$) is OFF, the output is turned OFF. (Ex. Guard is opened.)

III. If safety check signals are not supplied correctly to the receiving circuits, due to an error in the safety device or input circuit, the output is turned OFF immediately. Status of any detected error is displayed on the error LED, input LEDs and monitoring output. (Ex. Fault in the non-contact Interlock switch)

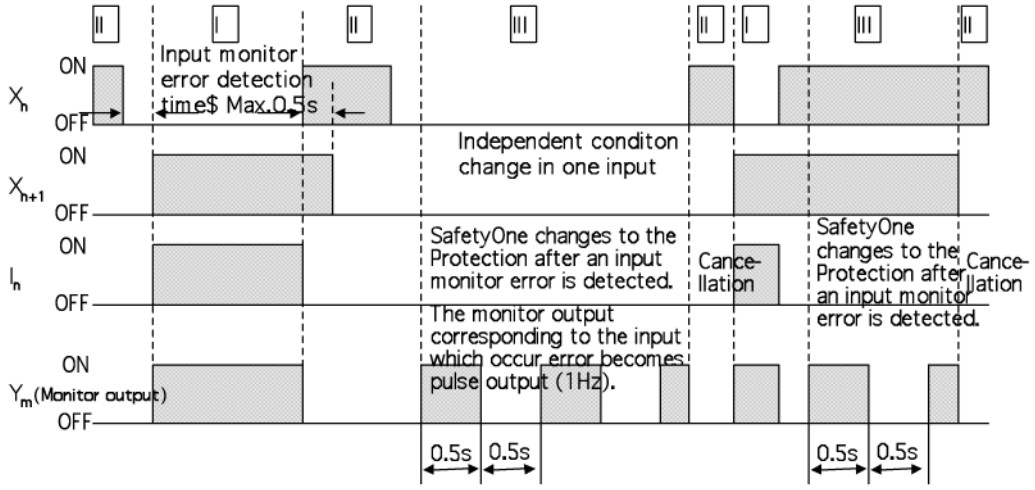



Fig. 5-6 Operation timing of a dual channel NO/NC input function

## Error detection function

**Input monitoring and grounding detection**

When an error is detected between the dual channel inputs, the SG-ONE changes to the Protection state and displays "1" on the error LED display. The conditions to be detected as input errors are shown below.

(1) When an input monitoring error detection time (0.5 s) is exceeded during the 2 input conditions is the same condition (namely ON/ON or OFF/OFF).

(2) When there is an independent condition change of 1 of the inputs.

(3) When the ON state input circuit has been grounded.

The input LEDs blink and the monitoring output ($Y_m$) sends pulses (1Hz), to notify the operator of the corresponding input. See Fig. 5-6.

**Short circuit**

When an input error, such as short circuit or circuit failure, is detected, the SG-ONE changes to the Stop state and displays "2" on the error LED display.

**Noise detection filter**

When the SG-ONE is used in an environment with severe noise, the SG-ONE changes to the Stop state and displays "9" on the error LED display.

**Warning**

Safety check signals (pulses signals) are supplied from the drive circuits ($T_n$) to diagnose connected safety devices and input circuits. Safety check signals can not be used as power for connected devices.

## Dual channel solid state input

This function is for connecting a safety device with a dual channel solid state output (PNP output), such as a safety light curtain or a safety laser scanner. As shown in Fig. 5-7, this function is comprised of a dual channel receive circuit ($X_n$, $X_{n+1}$) and a functional output ($I_n$). The drive circuit is not used because circuit monitoring is performed by connected safety devices.

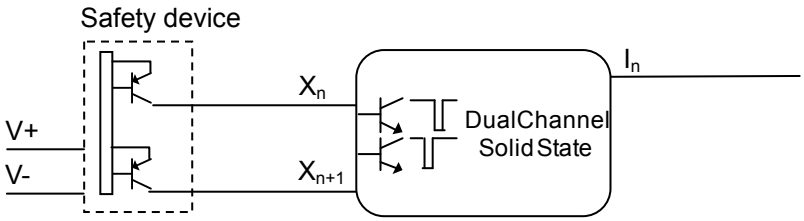



Fig. 5-7 Circuit for dual channel solid state input function

### Connects to

Safety devices with dual channel solid state outputs (PNP output), such as safety light curtains or safety laser scanners.

**Warning**

Mechanical contact devices, such as emergency stop switches or interlock switch, cannot be connected.

Note: Solid state output devices with sink outputs (NPN output) cannot be connected.

### Description of operation

The operation timing is described in Fig. 5-8.

I. When the dual channel safety check signals from the safety device are correctly supplied to the 2 input receiving circuits, the output is turned ON. (Ex. Safety light curtain is not shaded.)

II. When the safety check signal to either of the receiving circuits is turned OFF, the output is turned OFF immediately. (Ex. Safety light curtain is shaded.)

III. If safety check signals are not supplied correctly to the input receiving circuits, due to an error in the safety device or input circuit, the output is turned OFF immediately. Status of the detected error is displayed by the error LED, input LEDs and monitor output. (Ex. Fault in the light curtain or wiring)

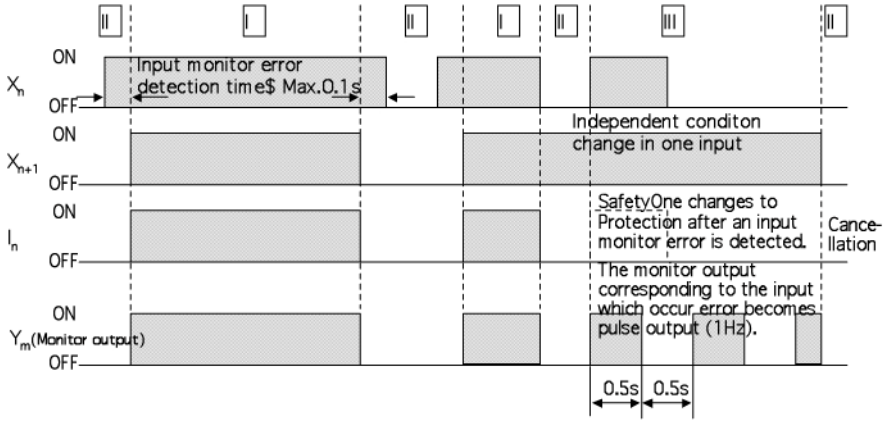



Fig. 5-8 Operation timing of a dual channel solid state input function

## Error detection function

**Input monitoring and grounding detection**

When an error is detected between the dual channel inputs, the SG-ONE changes to the Protection state and displays "1" on the error LED display. The conditions to be detected as input errors are shown below.

(1) When an input monitoring error detection time (0.1s) is exceeded during the 2 input conditions and they do not match (namely ON/OFF or OFF/ON).

(2) When there is an independent condition change of the 1 of the input.

(3) The input circuit of the ON state has gone to ground.

The input LEDs blink and the monitor output ($Y_m$) supplies pulses (1Hz), to notify the operator of the corresponding input. See Fig. 5-8.

**Noise detection filter**

When the SG-ONE is used in an environment with severe noise, the SG-ONE changes to the Stop state and displays "9" on the error LED display.

Note: Drive circuit corresponding to the dual channel solid state input ($T_n$, $T_{n+1}$) is always OFF.

## Mode select input

This function is for connecting devices with a mode select function, such as a selector switch.
As shown in Fig. 5-9, this function is comprised of 2 input receiving circuits ($X_n$, $X_{n+1}$), 1 drive circuit ($T_n$), and functional output (TEACH, AUTO).

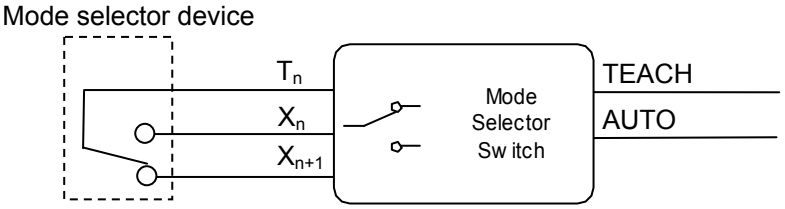



Fig. 5-9 Circuit for mode select input function

### Connects to

Mode selecting device such as a selector switch or a rotary switch

Note: This cannot be connected to a safety light curtain or any other safety solid state output.

### Description of operation

The operation timing is described in Fig. 5-10.

I-1 When a safety check signal from the drive circuit ($T_n$) is supplied to 1 of the receiving circuits ($X_{n+1}$), and the other receiving circuit ($X_n$) is OFF, the output “AUTO” is turned ON.

I-2 When a safety check signal from the drive circuit ($T_n$) is supplied to 1 of the receiving circuits ($X_n$), and the other receive circuit ($X_{n+1}$) is OFF, the output “TEACH” is turned ON.

II-1 When both receiving circuits are OFF, both of outputs “TEACH” and “AUTO” are turned OFF. (Ex. The selector switch is in the intermediate position.)

II-2 When both receiving circuits are ON, both of outputs “TEACH” and “AUTO” are turned OFF. And if the input monitoring error detection time is exceeded during the time both receiving circuits are ON, an input monitoring error is detected.

III If safety check signals are not supplied correctly to the receiving circuits due to an error in the selected mode device or input circuit, the output is turned OFF immediately. Status of the error is displayed by the error LED, input LEDs, and the monitoring output. (Ex. Fault in selector switch or wiring error)

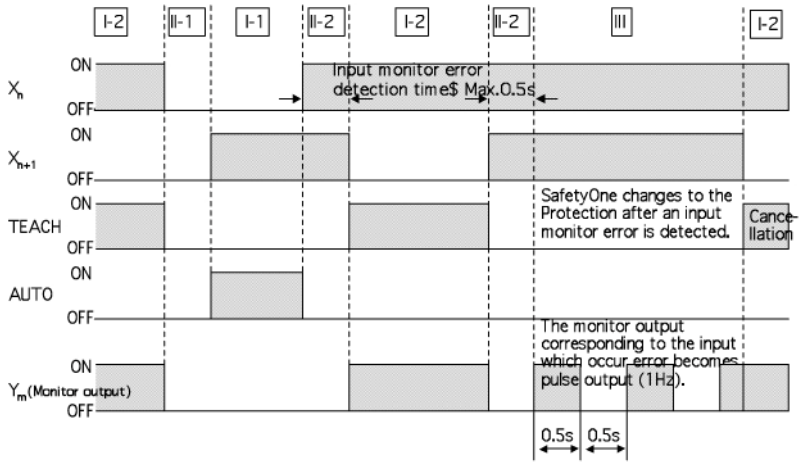



Fig. 5-10 Operation timing of a mode select input function

## Error detection function

**Input monitoring**

When an error is detected at the inputs, the SG-ONE changes to the Protection state and displays "1" on the error LED display. The condition to be detected as input error is shown below.

(1) When input monitoring error detection time (0.5s) is exceeded while both of the 2 input conditions are ON.

The input LEDs blink and the monitor output ($Y_m$) outputs pulses (1Hz), to notify the operator of the corresponding input. See Fig. 5-10.

**Short circuit detection**

When an input error, such as a short circuit, or a circuit failure, is detected, the SG-ONE changes to the Stop state and display "2" on the error LED display.

**Noise detection filter**

When the SG-ONE is used in an environment with severe noise, the SG-ONE changes to the Stop state and displays "9" on the error LED display.

**Warning**

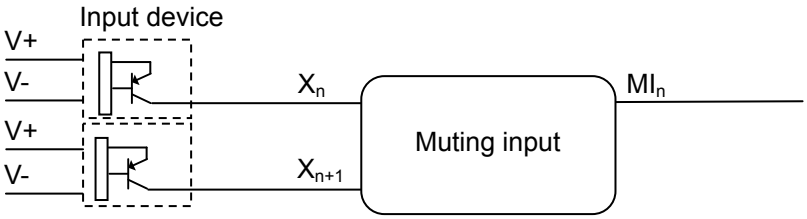
Safety check signals (pulses signals) are supplied from the drive circuits ($T_n$) to diagnose connected safety devices and input circuits. Safety check signals can not be used as power for connected devices.

Note: Drive circuit “$T_{n+1}$” is always OFF.

## Muting input

This function is for connecting a muting sensor with a solid state output (PNP output) or a mechanical contact device such as a limit switch. As shown in Fig. 5-11, this function is comprised of 2 input receiving circuits ($X_n$) and one functional output ($MI_n$).

For muting sensors with a solid state output (PNP)




・For a mechanical contact device

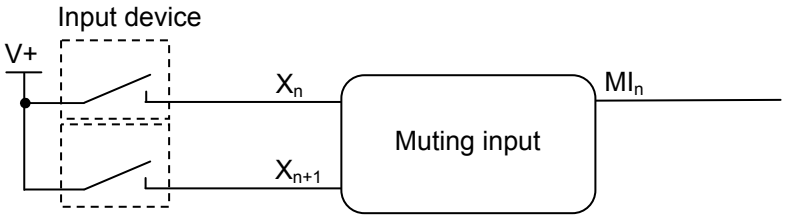



Fig. 5-11 Circuit for muting input function

### Connects to

Through-beam dark ON photoelectric switches with 3-wire PNP open collector outputs

Normally open proximity sensors with 3-wire PNP open collector output.

**Warning**

Do not use the muting input as safety input.

### Description of operation

The operation timing is described in Fig. 5-12.

Ⅰ When the 2 output signals from the muting input devices, such as muting sensor, are correctly connected to the 2 receiving circuits, the output is turned ON. (Ex. Sensor detects objects.)

Ⅱ When the input signal to either of receiving circuits is turned OFF, the output is turned OFF. (Ex. Sensor object detection is canceled.)

Ⅲ If safety check signals are not correctly supplied to the receiving circuit due to an error in the sensor device or input circuit, the output is turned OFF immediately. Status of the detected error is displayed by the error LED, input LEDs, and monitoring output. (Ex. Fault in sensor or wiring error)

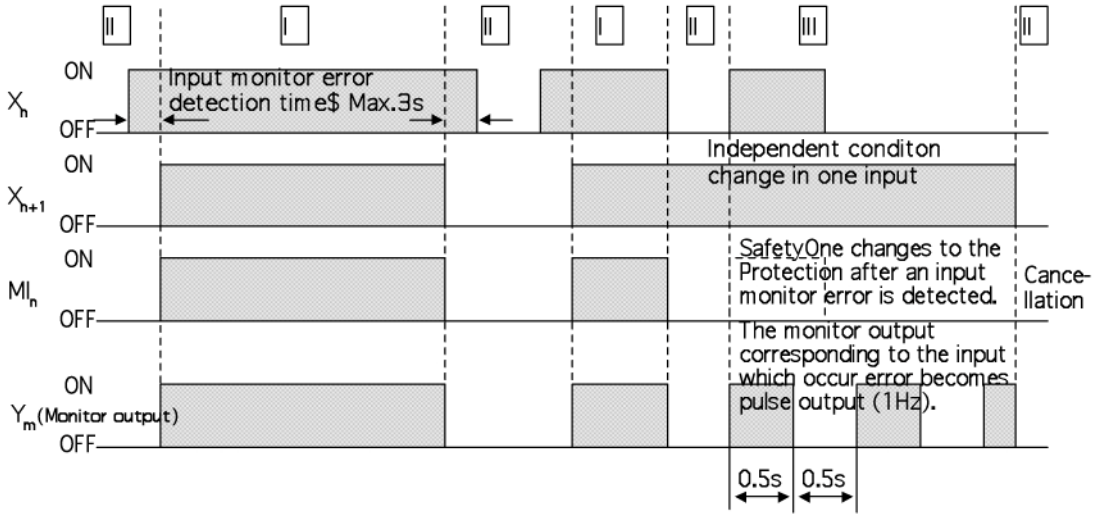



Fig. 5-12 Operation timing of the muting input function

## Error detection function

**Input monitoring and grounding detection**

When an error is detected at the inputs, the SG-ONE changes to the Protection state and displays "1" on the error LED display. The conditions to be detected as an input error are shown below.

(1) When the input monitor error detection time (3s) is exceeded during the 2 input conditions and they do not match (namely ON/OFF or OFF/ON).

(2) When there is an independent condition change of the 1 of the input.

(3) When the ON state of the input goes to the ground state.

The input LEDs blink and the monitoring output ($Y_m$) send pulses (1Hz), to notify the operator of the corresponding input. See Fig. 5-12

**Noise detection filter**

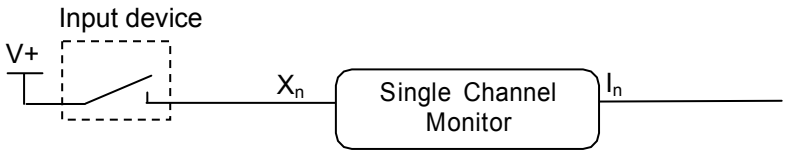
When the SG-ONE is used in an environment with severe noise, the SG-ONE changes to the Stop state and displays "9" on the error LED display.

Note: Drive circuit corresponding to muting input ($T_n$, $T_{n+1}$) is always OFF.

## Monitor input

This function is for connecting a switch (mechanical contact device) or sensor with a solid state output (PNP output) as the start input. As shown in Fig. 5-13, this function is comprised of 1 receiving circuit ($X_n$) and 1 functional output ($I_n$).

- For mechanical contact device




- For input device with solid state output (PNP)

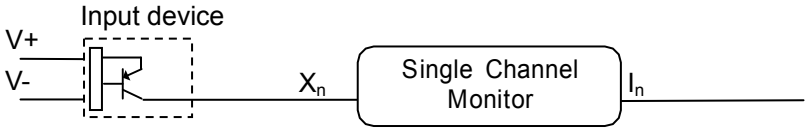



Fig. 5-13 Circuit for monitor input function

### Connects to

Input device such as a mechanical contact switch, a photoelectric switch, or a proximity switch

**Warning**

Do not use the monitor input as a safety input. When there is a failure in the SG-ONE or peripheral devices, the safety system will not function properly as intended.

### Description of operation

Operation timing is described in Fig. 5-14.

When the output signals from the start input device are correctly supplied to the receiving circuit, the output ($I_n$) turns ON.

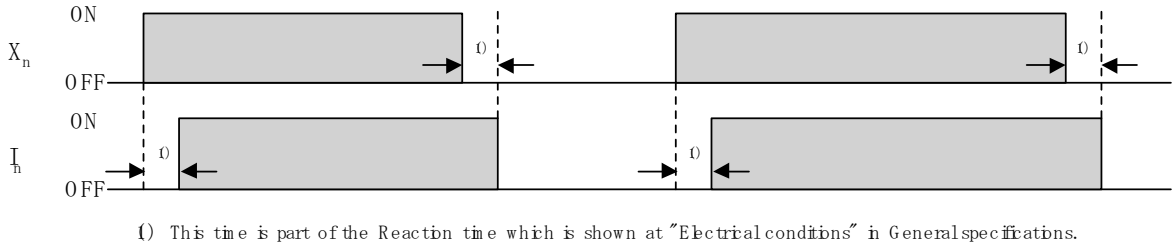



Fig. 5-14 Operation timing of the monitor input

### Error detection function

**Noise detection filter**

When the SG-ONE is used in an environment with severe noise, the SG-ONE changes to the Stop state and displays "9" on the error LED display.

## External device monitoring input

This function is for monitoring external devices controlled by the SG-ONE. External devices can be diagnosed for errors by connecting a NC contact, such as a contactor or a safety relay. As shown in Fig. 5-15, this function is comprised of an input receiving circuit ($X_n$), drive circuit ($T_n$), and functional output.

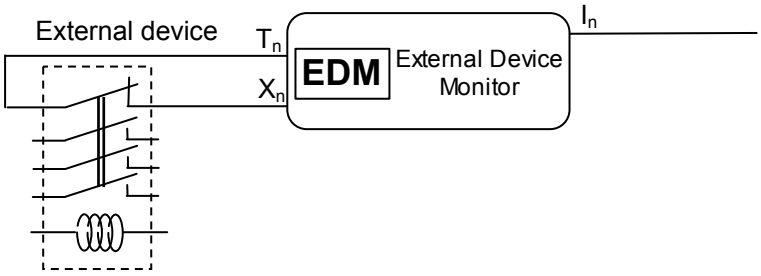



Fig. 5-15 Circuit for external device monitor input function

### Connects to

NC contact on devices such as a contactor, safety relay, or other devices equipped with forced guided mechanisms

Note: Solid state output devices cannot be connected.

### Description of operation

Ⅰ When a safety check signal from the drive circuit is supplied correctly to the receiving circuit, the output is turned ON. (Ex. External device is turned OFF.)

Ⅱ When safety check signal input to the receiving circuit is turned OFF, the output is turned OFF. (Ex. External device is turned ON.)

Ⅲ If the safety check signal is not supplied correctly to the receiving circuit due to an error in an external device or input circuit, the output is turned OFF immediately. Status of the detected error is displayed on error LED, input LED, and monitor output. (Ex. Fault in external device or wiring error)

### Error detection function

**Noise detection filter**

When the SG-ONE is used in an environment with severe noise, the SG-ONE changes to the Stop state and displays "9" on the error LED display.

# Logic operation function

## AND function

As shown in Fig. 5-16 and 5-17, this function reflects the results of a logic (AND) function processing for multiple inputs ($I_n$) in the function output ($O_n$).

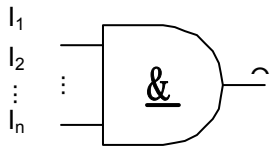



Fig. 5-16 AND function circuit

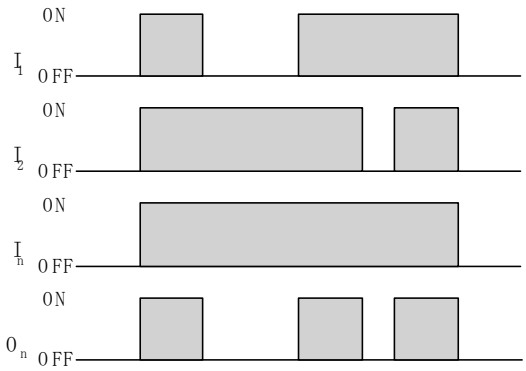



Fig. 5-17 Operation timing of the AND function

## OR function

As shown in Fig. 5-18 and 5-19, this function reflects the results of a logic (OR) function processing for multiple inputs ($I_n$) in the function output ($O_n$).

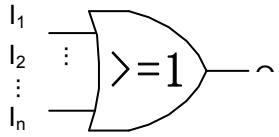



Fig. 5-18 OR function circuit

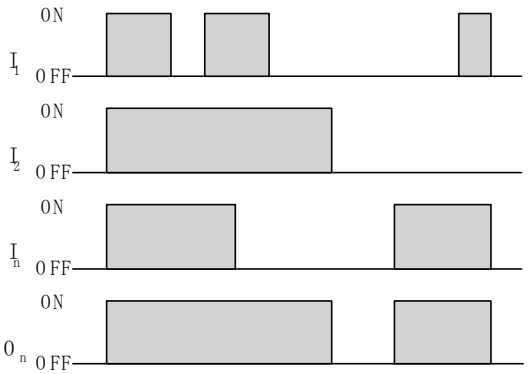



Fig. 5-19 Operation timing of the OR function

## XOR function

As shown in Fig. 5-20 and 5-21, this function reflects the results of an exclusive logic (XOR) function processing for multiple inputs ($I_n$) in the function output ($O_n$).

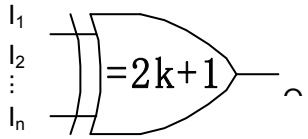



Fig. 5-20 XOR function circuit

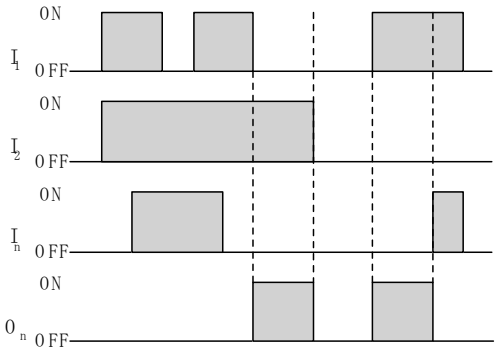



Fig. 5-21 Operation timing of XOR function

## Self-hold function

As shown in Fig. 5-22 and 5-23, this function is comprised of a hold input ($IH_n$), a trigger input ($IT_n$), and a functional output ($O_n$), and reflects the results of self-holding processing by the hold input and trigger input in the output.

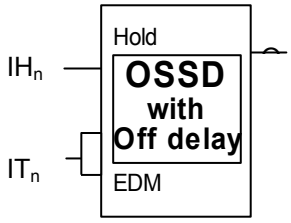



Fig. 5-22 Self-holding circuit

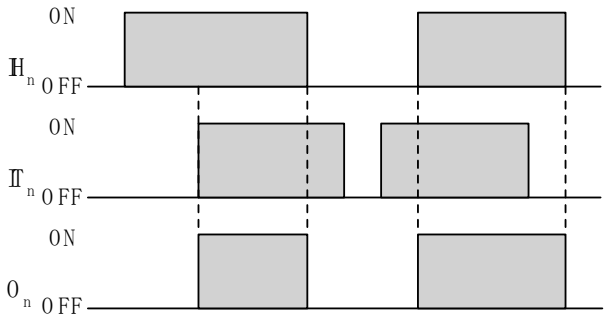



Fig. 5-23 Operation timing of the self-holding function

Note: When the SG-ONE changes to the Configuration, Protection, or Stop state, the self-holding function is canceled.

# Muting function

This function adds muting to the connected safety devices.

As shown in Fig. 5-24, this function is comprised of a safety input ($I_n$), a muting input ($IM_n$), and a functional output ($O_n$). The output of the muting input function is connected to the muting input ($IM_n$).

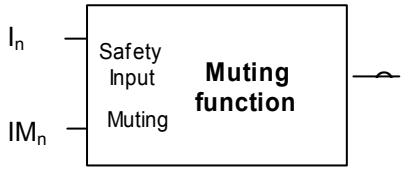



Fig. 5-24 Muting circuit

## Description of operation

The timing is described in Fig. 5-25.

Ⅰ When the muting input is turned ON while the safety input is ON, the OFF status of the safety input is suspended, and the output remains ON.

Ⅱ When the muting input is turned OFF, muting is canceled and the ON/OFF status of the safety input is shown by the output.

Ⅲ If muting is not used under the correct conditions, the muting function is disabled and the ON/OFF status of the safety input is shown by the output.

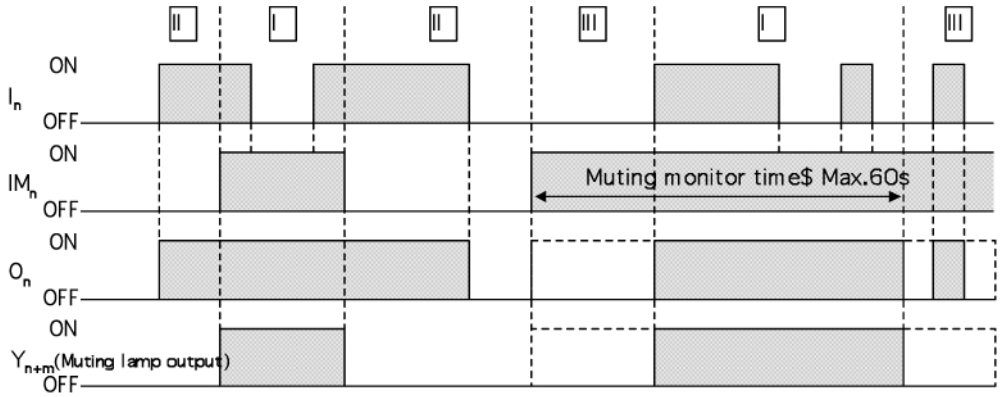



Fig. 5-25 Operation timing of the muting function

## Error detection function

**Muting monitor**

When either of the following conditions are satisfied, the SG-ONE disables the muting function.

(1) The muting function continues after the muting monitor time (60 s) is exceeded.

When the muting input ($MI_n$) ON status exceeds the muting monitoring time, the muting function is disabled and the safety input status becomes the output. When the muting input is turned OFF, the muting monitoring time is reset.

(2) When the safety device to be muted is OFF

When the muting input is turned ON while the safety input to be muted is OFF, the muting function is disabled.

Note: lamp outputs (Y17, Y20) have diagnostic functions of wire breaking or no connection of an indicator. When wire breaking or no connection of an indicator, the SG-ONE changes to the Stop state and displays "5" in the error LED display.

## Control start

This function confirms operation of the connected start input device. As shown in Fig.5-26, this function is comprised of a functional input ($I_n$) and a functional output ($O_n$).

The start input ($I_n$) ON operation is monitored to determine whether it is performed within the designated control time (0.1 s to 5 s).

Fig. 5-26 Control start circuit

### Description of operation

The operation timing is described in Fig. 5-27.

Ⅰ If the input turns ON within the designated control time (0.1 s to 5 s), the output turns ON until the connected self-holding function or another trigger input turns ON. (The function output turns OFF after the other trigger input turns ON.)

Ⅱ If the input does not turn ON within the designated control time (0.1 s to 5 s) (If the function input turns on before 0.1 s or after 5 s), the output does not turn ON.

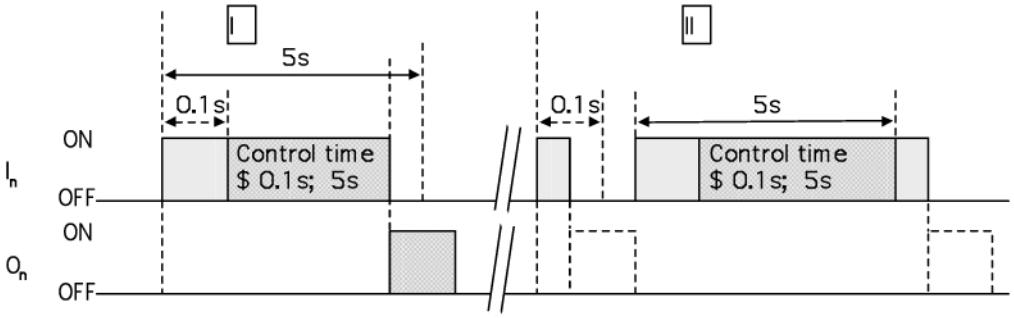



Fig. 5-27 Operation timing of the control start function

# Output function

## Safety output with timer

This function is for controlling the safety output.

As shown in Fig. 5-28, this function is comprised of a hold input ($O_n$), an EDM input ($I_n$), and a safety output ($Y_n$). The output of this external device monitoring input is connected to the EDM input ($I_n$).

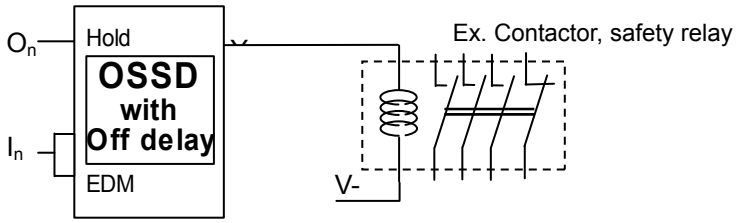



Fig. 5-28 Safety output with timer circuit

### Connects to

Equipment with force guided mechanisms, such as, contactors, safety relays.

Input of safety PLC, or another SG-ONE controller

### Description of operation

The operation timing is described in Fig. 5-29 and 5-30.

Ⅰ When hold input is turned ON, the safety output is turned ON after confirmation that the EDM input is ON.

Ⅱ When hold input is turned OFF, the safety output is turned OFF.

Ⅲ When the OFF-delay timer is set, after the hold input is turned OFF, the safety output is turned OFF after the set time of the OFF-delay timer. However, the monitor outputs (Y12 and Y13) for safety output are turned OFF immediately after the hold input is turned OFF regardless of the set time of the OFF-delay timer.

Ⅳ If the EDM input is not applied correctly (ON state of EDM input is detected during EDM monitoring time (1s) after hold input is turned ON) due to an error in the safety device or input circuit, the SG-ONE changes to the Protection state, and indicates “1” on the error LED without turning ON the safety output. (See Fig. 5-30.)

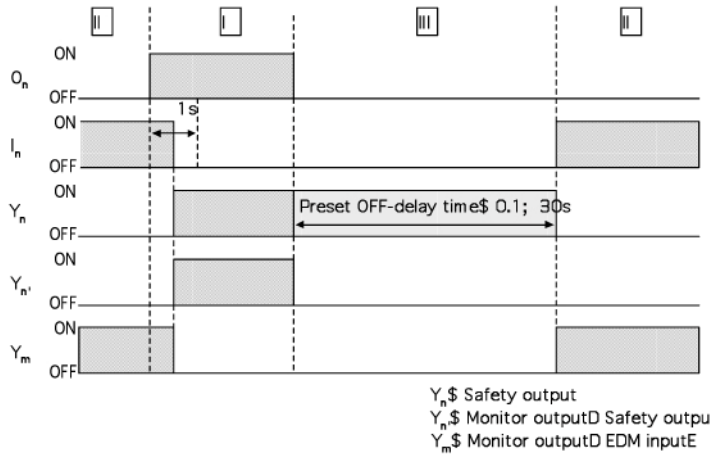


Fig. 5-29 Operation timing of safety output with timer

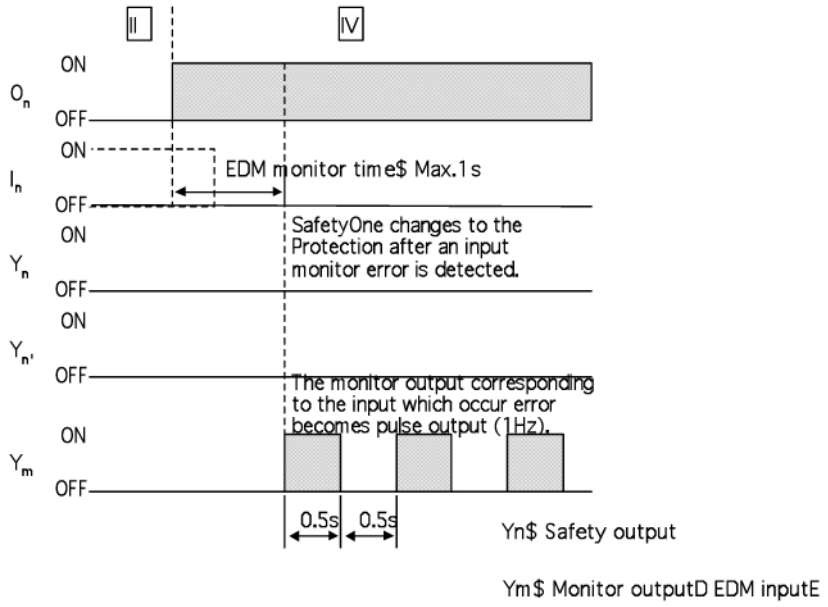



Fig. 5-30 Operation timing when EDM input error occurs

## Error detection function

**EDM input monitoring**

When the following condition is satisfied, the SG-ONE changes to the Protection state and displays "1" in the error LED display.

(1) When the EDM input does not turn ON within the EDM monitoring time (1 s) after the hold input turns ON

The input LEDs blink and the monitor output ($Y_m$) transmits pulses (1Hz), to notify the operator of the corresponding external device monitor input.

**Short circuit and grounding detection**

When an output error, such as short circuit, grounding or circuit failure, is detected, the SG-ONE changes to the Stop state and displays "4" on the error LED display.

Note: OFF check signals are outputted at a fixed interval while the safety output is ON for checking the OFF function of the output circuit. Refer to "Chapter 2 PRODUCT SPECIFICATION" for details.

# Chapter6 TROUBLE SHOOTING

This chapter describes how to determine the cause of a failure or error that occurs with the SG-ONE or connected device, and the measures to take to solve the problem.

## Error descriptions and troubleshooting

The SG-ONE uses advanced diagnostic functions to detect any problems within the SG-ONE and its peripheral devices, thereby ensuring the safety performance of the entire system. You can obtain information about a detected failure or error by using the error LED display, input LEDs, and monitor outputs.

Error information from error LED display and monitor outputs

| Error LED | Monitor output | | | Description | Cause | Possible solution |
|---|---|---|---|---|---|---|
| | Y14 | Y15 | Y16 | | | |
| | OFF | OFF | ON | Normal operation | - | - |
| 1 | OFF | ON | OFF | Input monitor error | 1. Fault in the dual channel input<br><br>2. Fault in the muting input<br><br>3. Both inputs of the mode selector inputs are ON<br>4. EDM input is OFF | 1. Turn OFF the corresponding dual channel input.<br><br>2. Turn OFF the corresponding muting input.<br>3. Turn OFF 1 of mode selector inputs.<br><br>4. Turn ON the corresponding EDM input. |
| 2 | ON | OFF | OFF | Fault in safety input wiring or safety input circuit | Broken or shorted safety input wiring<br><br>Fault in safety input device | Check safety input wiring.<br><br>Check operation the safety input device. |
| 3 | ON | OFF | OFF | Fault in start input wiring or start input circuit | Shorted start input wiring<br><br>Fault in start input device | Check start input wiring.<br><br>Check operation of the start input device. |
| 4 | ON | OFF | OFF | Fault in safety output wiring or safety output circuit | Shorted safety output wiring<br><br>Fault in safety output device | Check safety output wiring.<br><br>Check operation of safety output device. |

| | | | | | | |
|---|---|---|---|---|---|---|
| 5 | ON | OFF | OFF | Muting lamp error (broken wire)<br>(For logic 4 only) | Broken wire of muting lamp wiring<br><br>Broken wire of Muting lamp | Check functionality and wiring of the muting lamp.<br><br>Check the operation of the muting lamp. |
| 6 | ON | ON | OFF | Fault in power supply or internal power supply circuit | The voltage of the power supply to SG-ONE is not within the allowable range. | Check voltage of the power supply to the SG-ONE. |
| 7 | ON | ON | OFF | Fault in power supply or internal power supply circuit | The voltage of power supply to SG-ONE is not within the allowable range. | Check voltage of power supply to SG-ONE. |
| 7 | ON | OFF | OFF | Internal circuit error | Internal failure of the SG-ONE | Replace the SG-ONE. |
| 9 | ON | OFF | OFF | Noise filter error | Noise influences to the SG-ONE or input/output line. | Check noise in the surrounding environment. |
| C | OFF | ON | OFF | Changing to the Configuration state | - | - |

The state of the input LEDs and monitoring output varies depending upon the logic selected. Refer to “Chapter 4 BASIC OPERATIONS” and "Chapter 5 LOGIC" for details.

# Chapter7 APPENDIX

## Minimum Distance

The minimum distance is the distance required to minimize the risk of contact with the hazard in the danger zone.

Be sure to maintain a sufficient minimum distance while taking into consideration the stopping time of the entire system, including the reaction time of the SG-ONE and the reaction time of any connected devices. If sufficient minimum distance is not maintained, the machinery may not be able to come to the sudden stop before a person meets a hazard, resulting in death or serious injury.

**Calculating the minimum distance when connecting a safety light curtain**

**■ For ISO 13855-2002**

You must take the following 5 points into consideration when determining the minimum distance.

1. Reaction time of the safety light curtain and SG-ONE
   (The time it takes for the safety outputs of the SG-ONE are turned OFF after the safety light curtain is shaded)
2. Stopping time of the machinery
   (The time it takes for dangerous machinery operation to come to the stop after the safety outputs of the SG-ONE are turned OFF)
3. Size of the minimum detectable object of the safety light curtain
4. Speed of the detected object entering the danger zone
5. Height of the maximum allowable optical axis of the safety light curtain

Parameters

S: Minimum distance (mm)

K: Speed of the detected object, arm or leg entering the danger zone (mm/s)

Tc: t1+t2

( t1: Reaction time of the SG-ONE (s)
t2: Preset OFF-delay time of the SG-ONE (s) )

T1: Reaction time of the safety light curtain (s)

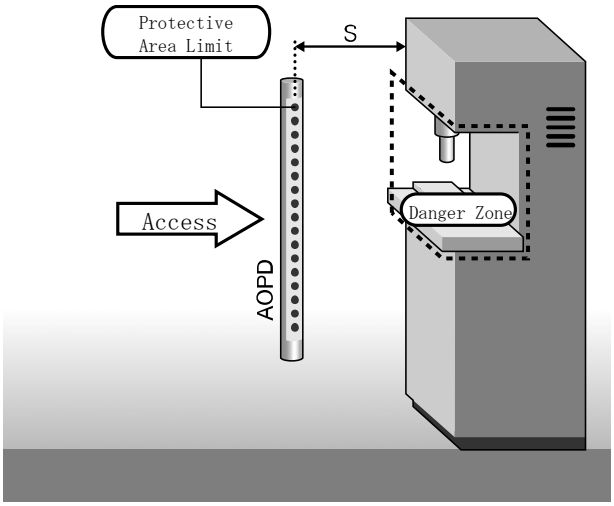
T2: Maximum time from when the safety output of SG-ONE is turned OFF to when the hazard is stopped (s)

C: Additional distance calculated from the minimum detectable object of the safety light curtain (mm)

H: Height of the maximum allowable optical axis of the safety light curtain

β: Angle of the ground surface and the safety light curtain to the direction of entry

**Example in which the direction of entry is perpendicular to the safety light curtain**




**When the size of the minimum detected object is 40 (mm) or smaller**

Use the following formula to calculate the minimum distance.

S=K×(Tc+T1+T2)+C

Tc=t1+t2

If using the SG-ONE and a safety light curtain, the following parameters are used for the above formula.

K=2000 (mm/s)

t1=0.04 (s)

t2=0 (s), 0.1 (s), 0.5 (s), 1 (s), 2 (s), 5 (s), 15 (s), 30 (s)

T1 (s) (Check the specifications of the safety light curtain)

T2 (s) (Check the maximum time from when the safety output of the SG-ONE is turned OFF when the hazard is stopped)

C=8× (Size of the minimum detectable object of the safety light curtain d (mm)-14 (mm))

Under the above conditions, when the minimum distance (S) is less than 100 (mm), it becomes 100 (mm).

When the minimum distance (S) is greater than 500 (mm), calculate again with K=1600 (mm/s). When the result of the recalculation with K=1600 (mm/s) is less than 500 (mm), it becomes 500 (mm).

**When the size of the minimum detected object is greater than 40 (mm)**

Use the following formula to calculate the minimum distance.

S=K×(Tc+T1+T2)+C

Tc=t1+t2

K=1600 (mm/s)

t1=0.04 (s)

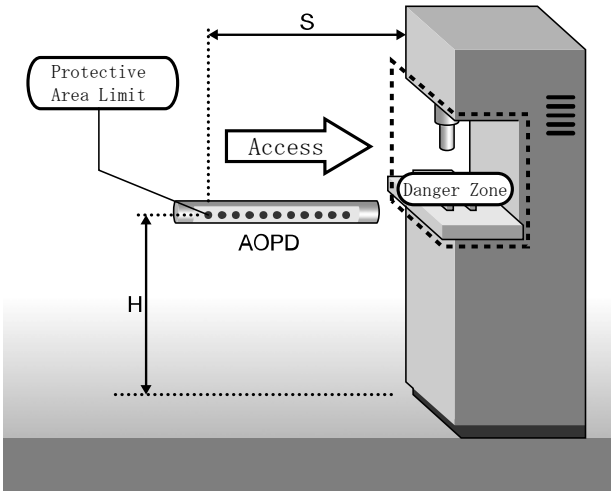
t2=0 (s), 0.1 (s), 0.5 (s), 1 (s), 2 (s), 5 (s), 15 (s), 30 (s)

T1 (s) (Check the specifications of the safety light curtain.)

T2 (s) (Check the maximum time from when the safety output of the SG-ONE is turned OFF when the hazard is stopped)

C=850 (mm)

**Example in which the direction of entry is horizontal to the safety light curtain**




Use the following formula to calculate the minimum distance (distance to the farthest optical axis).

S=K×(Tc+T1+T2)+C

Tc=t1+t2

C=(1200-0.4×H)

K=1600 (mm/s)

t1=0.04 (s)

t2=0 (s), 0.1 (s), 0.5 (s), 1 (s), 2 (s), 5 (s), 15 (s), 30 (s)

T1(s) (Check the specifications of the safety light curtain.)

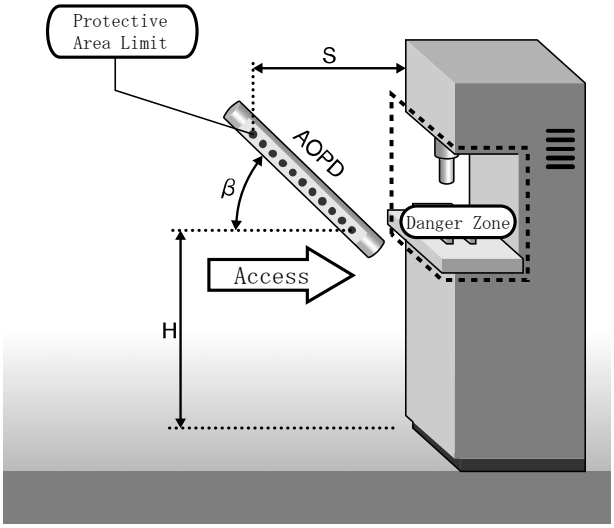
T2(s) (Check the maximum time from when the safety output of the SG-ONE is turned OFF when the hazard is stopped)

C=(1200－0.4×Height of the optical axis H(mm)) (However, C≥850(mm))

The height of the maximum allowable optical axis (H) must be within a range of 15 (d-50 (mm)) ≤H≤1000 (mm).

Furthermore, when the value of H calculated using H≥15 (d-50) is H≥300 (mm), there is an unexpected proximity risk in where objects cannot be detected below the detection zone. This must be taken into consideration for a risk assessment.

**Example in which the direction of entry is at an angle to the safety light curtain**




The angle of entry is set within a range of 5°≤β≤85°.

At β>30°, the direction of entry is calculated as being perpendicular.
At β<30°, the direction of entry is calculated as being horizontal.

The minimum distance is the distance to the farthest optical axis, and the height of the optical axis is calculated using ≤1000 (mm).

The height of the lowest optical axis is calculated using H≥15 (d-50) (mm).

**■ For ANSI B11.19**

Use the following formula to calculate the minimum distance.

S=K×(Ts+Tc+Tr+Tbm)+Dpf

Tr=t1+t2+T1

Parameters

S: Minimum distance (mm)

K: Speed of the detected object or arm or leg entering the danger zone (mm/s)

However, the speed of entry K is not defined by ANSI B11.19.
Take into consideration various factors such as the physical ability of the operator.

The OSHA recommended value is K=63 (inch/s)=1600 (mm/s).

Ts: Machinery stopping time (s) as calculated from the last control elements (air valves, etc.) to come to a stop

Tc: Maximum reaction time (s) of the machine control circuit required for operating the machine brake

Tr: t1+t2+T1

t1: Reaction time of the SG-ONE (s)
t2: Preset OFF-delay time of the SG-ONE (s)
T1: Reaction time of the safety light curtain (s)

Tbm: Additional stop time allowed by the brake monitor (s)

If the machinery is equipped with a brake monitor, the following formula applies.
Tbm=Ta-(Ts+Tc)
Ta: Brake monitor set time (s)
(If the machinery is not equipped with brake monitor, it is recommended that 20% or more of (Ts+Tc) become an additional stop time.)

Dpf: Additional distance calculated from the minimum detected object of the safety light curtain (mm)

Dpf=3.4×(d-0.275) (inch)
=3.4×(d-7) (mm)
However, Dpf cannot be 0 or less.

In case of using the SG-ONE and a safety light curtain, the following parameter is used for the above formula.

K=63 (inch/s)=1600 (mm/s)

Tr=t1+t2+T1 (s)

t1=0.04 (s)
t2=0 (s), 0.1 (s), 0.5 (s), 1 (s), 2 (s), 5 (s), 15 (s), 30 (s)
T1 (s) (Check the specifications of the safety light curtain.)

# Maintenance and Inspection

**Warning**

To ensure safety, use the SG-ONE after performing inspections described below and confirming that the entire safety system incorporating the SG-ONE is operating normally.
The following checklist contains only the minimum items for use of the SG-ONE. Depending on the machinery on which the SG-ONE is installed and the regulations that apply in the country or region where the SG-ONE is used, additional inspection items may be required.

Note. Record and store the inspection results.
Perform inspections with a clear understanding of the operations of the SG-ONE and the machine on which it is used.

**Daily inspection**

Each day before beginning operations, check the following items.

| Inspection items | Check |
|---|---|
| Check that the power supply of the SG-ONE is OFF. | |
| Check that the power supply of the machine being controlled by the safety output of the SG-ONE is OFF. | |
| Before turning ON the power supply of the SG-ONE, make sure that no person is in the danger zone. | |
| Check that there is no damage on the input devices and wiring. | |
| Operate the connected safety devices, and check that they are operating normally.(Ex. Press the emergency stop switch, shade the light curtain) | |

**Periodic inspection**

Every testing interval and after changing the settings of the machinery, check the following items.

| Inspection items | Check |
|---|---|
| Check that unintended changes are not introduced into the safety system. | |
| Check that the safety system incorporating the SG-ONE operates as expected. | |
| Check that the SG-ONE is installed securely. Check that the DIN rail hooks has not come off and that the DIN rails and end clip screws are not loose. | |
| Check that the connectors and the wiring are not loose. | |
| Check that the protective cover is on the SG-ONE to prevent changes to the logic or OFF-delay timer setting by anyone other than the safety responsible person. | |

Note: Refer Safety performance in “Chapter 2 PRODUCT SPECIFICATIONS” about proof test interval.

## Type number

| Item | Type number |
|---|---|
| Module | SG-ONE-T4-8C |

## Accessories

| Item | Quantity |
|---|---|
| Input connector | 1 |
| Output connector | 1 |
| Configuration tool | 1 |
| Marking tie | 3 |
| Instruction sheet (English/Italian) | 1 for each |
| CD wiyh instruction manual and other documents | 1 |